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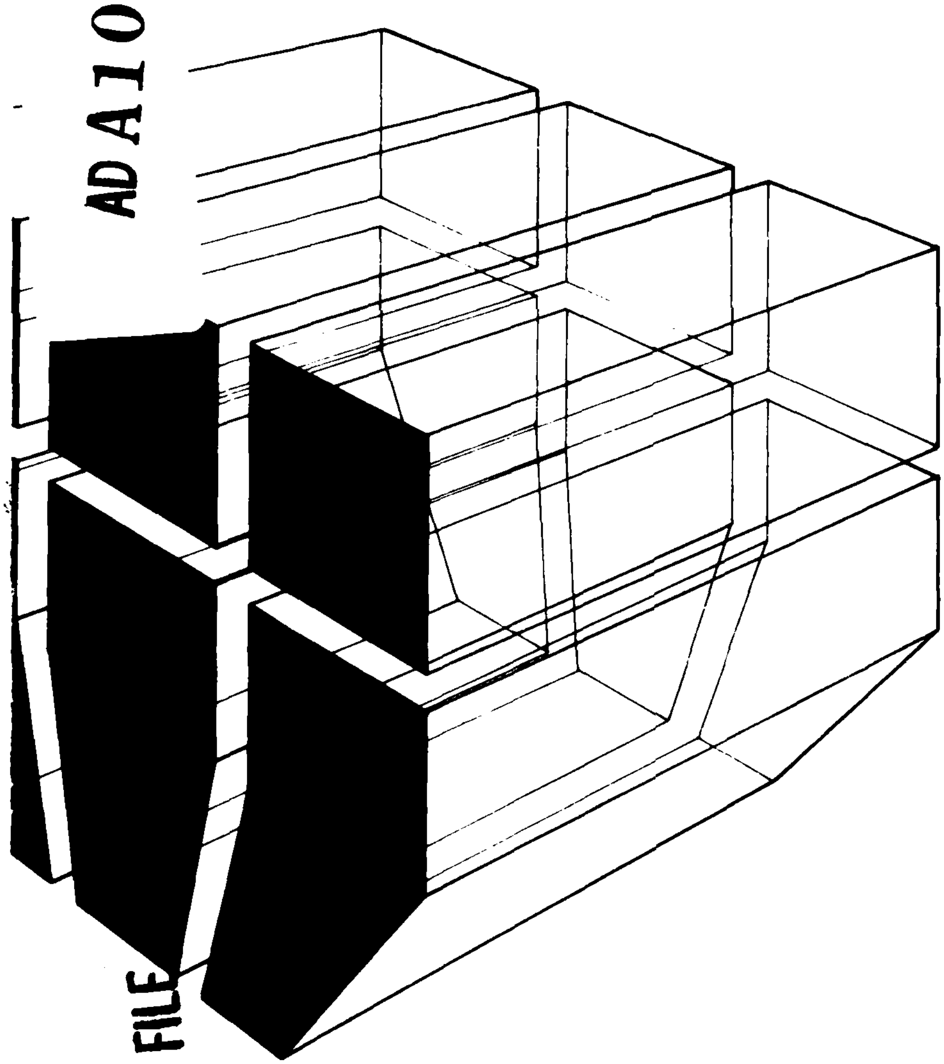
June 1981
Guidelines for Natural Resources Management
and Land Use Compatability

NATURAL RESOURCE CONSIDERATIONS FOR TACTICAL VEHICLE TRAINING AREAS



by
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This report provides land evaluation criteria and procedures for incorporating environmental and natural resource considerations into the process of choosing sites for tactical vehicle training. Environmental and natural resource elements which are addressed include land use, noise, terrain, soil, air quality, water quality, vegetation and wildlife. Procedures to lessen the impact of tactical vehicle training on these resources are suggested. A simple technique for recording evaluation results and site recommendations is provided.

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Block 20 continued.

The guidance presented in this report is designed to be as nontechnical as possible. It can be applied by persons with varying levels of expertise in environmental and natural resource management. The guidance can be used to respond quickly and accurately to requests for input into training area site selection and for the preliminary environmental analysis of alternative sites. Users may include persons in the installation's natural resource, environmental, master planning, or Directorate of Plans and Training offices.

The procedures and techniques will enable the user to systematically compare the suitability of the environmental and natural resources of alternative areas. This will aid in more environmentally sensitive site selection and decision-making.

FOREWORD

This investigation was performed for the Directorate of Military Programs, Office of the Chief of Engineers (OCE), under Project 4A762720A896, "Environmental Quality for Construction and Operation of Military Facilities"; Task B, "Land Use Planning"; Work Unit 024, "Guidelines for Natural Resources Management and Land Use Compatibility." The applicable QCR is 3.01.001. The OCE Technical Monitor was Mr. Donald Bandel, DAEN-MPO-B.

The work was performed by the Environmental Division (EN), U.S. Army Construction Engineering Research Laboratory (CERL). The assistance and technical advice of other members of the EN Division is gratefully acknowledged. Specifically recognized is the technical assistance provided by Dr. R. Raspet, G. Schanche, R. Riggins, and R. Fileccia. Dr. R. K. Jain is Chief of EN.

COL Louis J. Circeo is Commander and Director of CERL, and Dr. L. R. Shaffer is Technical Director.

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NATURAL RESOURCE CONSIDERATIONS FOR TACTICAL VEHICLE TRAINING AREAS

1 INTRODUCTION

Background

With the U.S. Army's present technology and weapons systems, the average battalion is expected to move responsively during combat in an area as large as 80,000 acres (32 385 ha).[1] To maintain an acceptable state of combat readiness, Army platoons, companies, and battalions must train in situations which simulate combat; this requires the use of considerable land.[2]

The Department of the Army manages, for military training purposes, nearly 12 million acres (4 858 300 ha) of Federally owned land. This acreage is located in a variety of environments -- e.g., arid climates, the central plains, and hardwood forests. Many of the training activities required to maintain combat readiness can have a considerable impact on the natural resources in these environments. As a trustee of Federally owned land, the Army is responsible for proper land management to avoid or reduce significant or long-term impacts to land and natural resources. Any avoidable, significant, or long-term impact to land and natural resources conflicts with the goals of Army Regulation (AR) 200-2, "Environmental Quality; Environmental Effects of Army Actions," and the National Environmental Policy Act (NEPA).[3]

When Army installations decide to set up a new training area or allow a new type of training in an established area, many variables are considered: scheduling, training needs, use conflict, existing facilities, and safety. Methods to coordinate these decisions with the various directorates on an installation vary among commands and installations.

Contact with the various offices or sections, including the natural resource section of the installation Facilities Engineer (FE) office, is generally included in this coordination. However, many times this contact does not offer an opportunity for constructive input or recommendations related to environmental or natural resources management. This is primarily because of the lack of a simple, quick and acceptable method by which to identify natural resource and environmental concerns. To assist in the coordination, and to comply with AR 200-2, there is a need for a system or set of procedures which can be used to evaluate the land and natural resource suitability of areas proposed for training. This system should provide simple, illustrative

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1 Training Land: Unit Training Land Requirements, Training Circular (TC) 25-1 (Department of the Army [DA], 4 August 1978), p 11.

2 Training Land: Unit Training Land Requirements, p 4.

3 "Environmental Quality; Environmental Effects of Army Actions," Army Regulation (AR) 200-2, Federal Register, Vol 45, No. 204 (20 October 1980), pp 69,215-69,238, and National Environmental Policy Act of 1969 (P.L. 91-109; 83 Stat. 851).

materials which the Directorate of Plans and Training (DPT) or other offices can use to make decisions about training areas.

The U.S. Army Construction Engineering Research Laboratory (CERL) has previously developed a systematic method to evaluate Army lands for possible use by off-road recreational vehicles.[4] Since the procedures and results are easy to apply and interpret, it was logical to adapt them to evaluate Army lands for tactical vehicle training.

Purpose

The purpose of this report is to provide criteria and methods for evaluating land and natural resources in areas being considered for tactical vehicle training.

Approach

A literature search was conducted to gather information and identify guidance documents related to various types of training activities -- e.g., field manuals (FMs), training circulars (TCs), and Army Training and Evaluation Program documents (ARTEPs). Laboratory personnel with expertise in various disciplines and field personnel with various training and environmental management responsibilities were interviewed to determine the nature and scope of conflicts between training and natural resource management. A search of technical literature was then conducted to identify resource evaluation and impact mitigation techniques applicable to these conflicts.

From the information gathered, simple criteria for evaluating the lands and resources in tactical vehicle training areas were developed. Training requirements and the effects of training were considered for these criteria. Procedures were developed which would allow the criteria to be used in an overall method of evaluation. Various ways to display the overall results of the evaluative method (e.g., checklists and matrices) were then analyzed, and a simple one-page form for comparing resources and alternative sites was developed. When accompanied by recommendations on site selection and mitigation techniques, the form can be used to make natural resource considerations a part of the process of choosing training areas.

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[4] Facilities Engineering -- Evaluation of Areas for Off-Road Recreational Motorcycle Use, Engineer Technical Note (ETN) No. 80-9 (DA, Office of the Chief of Engineers [OCE], 4 March 1980); R. M. Lacey, H. E. Balbach, R. S. Baran, and R. G. Graff, Evaluation of Areas for Off-Road Recreational Motorcycle Use, Volume I: Evaluation Method, and Volume II: Alternate Soil Suitability Determination, Technical Report N-86 (U.S. Army Construction Engineering Research Laboratory [CERL], December 1980).

Scope

The criteria described in this report were developed specifically for evaluating areas for tactical vehicle training. This type of training was chosen as the focus of the evaluative method since it generally causes the most significant impacts to natural resources. With certain modifications to the criteria, the procedures may be made applicable to other types of training.

The method allows for the evaluation of eight general categories of land and natural resource environment: land use, noise, terrain, soil, air quality, water quality, vegetation, and wildlife. The criteria and procedures described were developed to be as nontechnical as possible so they could be applied by personnel with different levels of knowledge in natural resource management.

The method was not designed to take the place of a detailed environmental assessment of training actions. However, the information and results generated with the method often can be used in required environmental analysis documents.

Mode of Technology Transfer

When the criteria and procedures outlined in this report have been subjected to a detailed field evaluation, it is anticipated that they will be issued as a training circular in the TC 25 series, "General Management."

Outline of This Report

Chapter 2 provides general information about the users of this report and about preparation for making an evaluation. Chapters 3 through 10 address each of the eight general categories of land and natural resources. Chapters are further divided into three basic subsections: (1) site selection criteria and considerations, (2) evaluative procedures, and (3) recommended mitigation procedures for impacts.

Chapter 11 provides a simple method for developing an overview display of the information generated as a result of the examination of each of the eight resource categories. This information display technique allows the user to assign a relative degree of acceptability to each resource category for alternative sites and to consolidate this information for comparison of alternatives. The chapter also provides suggestions for transferring this information to the decision-maker. Transfer of appropriate mitigation techniques and site selection recommendations is also discussed.

2 GENERAL

Users

Since the evaluative method described in this report was developed for persons with different levels of expertise in natural resource management, users can include personnel in the natural resource, environmental, and master planning offices of the FE and personnel in the DPT office.

Natural Resource Personnel

Persons with responsibilities for managing an installation's natural resources under the authority of AR 420-74 will find the method particularly useful when asked to make suggestions about training site selection.[5] Often, only limited time is available for site evaluation and response. Use of the method can assist natural resource and land management personnel in quickly and accurately evaluating sites and comparing alternative sites. Furthermore, the method allows site evaluation and comparison results to be reported in a simple format. Thus, the resource manager can provide both constructive input and recommendations which can be easily interpreted by the decision-maker.

Environmental Personnel

The evaluative procedures can be used by both generalists and specialists in environmental protection. Therefore, environmental office personnel can use the method to provide input into training site selection. The benefits of easy comparison of alternatives and display of information are the same. If certain procedures require more technical expertise than might be available, coordination between the environmental and natural resource offices is recommended. In this way, all elements of the environment receive professional examination and equal consideration.

Environmental and other personnel will also find the method useful for complying with AR 200-2. Under this regulation, any action which might significantly affect the environment must undergo detailed environmental evaluation and analysis. Tactical vehicle training is an action which certainly has the potential to create significant impacts.

The evaluative method is not intended to be the user's sole guidance in environmental assessment and statement preparation. However, it can help identify issues to be addressed in documenting environmental analysis. The procedures in this report can be used to preliminarily identify, and in some cases quantify, the environmental impacts associated with tactical vehicle training. The suggested mitigation procedures will also be useful since environmental analysis and documentation require identification of such procedures.

[5] Natural Resources: Land, Forest, and Wildlife Management, Army Regulation (AR) 420-74 (DA, 1 July 1977).

Master Planning Personnel

As with natural resource and environmental personnel, persons in the master planning office can use the procedures to provide input into training site selection. The procedures can also provide information on the master planning process as required in AR 210-20.[6] Paragraph 3-5 of this regulation requires that an Analytical/Environmental Assessment Report be prepared. This report must consider the relationships between existing installation land uses and include an identification of the expected or anticipated environmental impacts of proposed land use changes or increases and decreases in activity. The AR also states that open operational areas, such as maneuver areas, will receive first consideration.[7]

Information obtained through use of the procedures relates directly to identifying the impacts of changes in land use -- particularly in open operational areas. This information can be the basis for preparing and updating the Analytical/Environmental Assessment Report and recommending tactical vehicle training areas.

For example, if an area is opened to tactical vehicle training, timber may have to be cleared. This affects the land's future potential for timber production. Clearing and subsequent tactical vehicle operations reduce vegetation cover, thus increasing the possibility of wind and water erosion. Depending on prevailing winds and the local watershed, dust or silt in streams may affect the quality of nearby land uses, both on and off post, especially residential and water-oriented recreational land uses.

The previous example is hypothetical, but reasonable. It illustrates the type of land use conflict and considerations which can be identified using the procedures. Appropriate mitigation techniques or alternative sites can be chosen accordingly.

Directorate of Plans and Training Personnel

Persons in the DPT offices and other personnel responsible for training area planning, scheduling, and site selection can use the procedures before actually proposing that an area be opened or used for tactical vehicle training. To use the evaluative procedures effectively, DPT personnel may have to coordinate with the FE offices.

Use of the procedures and early coordination will serve two purposes. First, early consideration of land and natural resources ensures more environmentally sensitive decisions. Second, early coordination should help to reduce later conflicts over environmental issues and delay in establishing or opening an area to tactical vehicle use. These benefits conform to the objectives and the spirit of NEPA and the new Council on Environmental Quality

[6] Installations -- Master Planning for Army Installations, AR 210-20 (DA, 26 January 1976).
[7] Para. 3-5b(3)(g)1, pp 3-5 through 3-8.

(CEQ) regulations for implementing the procedures for environmental analysis required by NEPA.[8]

Pre-Evaluation Recommendations

Before going through the evaluative method, the user should become familiar with the reports and information applicable to the functions and responsibilities of other persons involved in training, site selection, and natural resource management. For example, the natural resource or land manager should become familiar with the Tables of Organization and Equipment (TOEs), TCs, FMs, and ARTEPs applicable to the type of training to be done. He* should also review the installation's master planning and environmental quality program documents. It is further recommended that all applicable documents and plans which are his responsibility be reviewed -- e.g., land management and fish and wildlife plans.

It will not be necessary for the user to make a detailed examination of each document. A simple review should provide the user appropriate information to begin the evaluation procedures. The review is required to help the user develop a realistic picture of the type of training activity and maneuvers to be performed, the equipment and manpower to be used, and the environmental characteristics of and future plans for the land.

It is also recommended that the user interview or conduct coordination meetings with others involved in the site selection process. This coordination need not be official; it is suggested that it be as informal as possible. The coordination will supplement the initial document review and will allow all parties involved to fully explain the proposed training site's relationship to their area of expertise or responsibility.

As a result of the document review and coordination meetings, the user should have acquired a good understanding of both the proposed action and the affected environment. This should be the case for all users, whether they are in the natural resource, environmental, master planning, or DPT office. A good understanding of both the action and the environment is necessary to complete the evaluation procedures and identify or recommend any appropriate mitigation techniques or alternative sites for the proposed training.

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[8] Council on Environmental Quality, Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act, 40 CFR, Parts 1500-1508 (29 November 1978).

* The masculine pronoun is used throughout this report to refer to both genders.

3 LAND USE

Land Use Considerations

Present and planned uses of the land are the principal considerations in evaluating land use. Army land is now used for a variety of activities. However, Federal lands under Army control or jurisdiction and used for military activities were acquired solely for national defense purposes. Therefore, other uses are secondary to mission needs.

Many installation lands will be incompatible with tactical vehicle training areas. The efficient operation of an installation precludes the use of a certain amount of land for training -- e.g., areas for troop housing, transportation, and facility and equipment operation and maintenance activities. In addition, by virtue of its control of publicly-owned land, the Army is a trustee of a fixed national asset. The protection and enhancement of the environment and the orderly use and development of this land are not only inherent responsibilities of trusteeship, but are also required by Federal mandate, e.g., NEPA. Therefore, certain land areas that are environmentally sensitive may be incompatible with tactical vehicle training.

The procedure described in this chapter can be used for initial site selection and for alternative site evaluation. It will assist the user in identifying if a proposed site is an existing incompatible land use or if a site might conflict with adjacent land uses.

Many of the evaluative procedures for other resources will also identify land-related restrictions on the use of tactical vehicle training areas. For example, the procedure for noise evaluation is based on adjacent noise-sensitive land use, and air quality considerations are related to adjacent downwind land use. Therefore, the land use considerations for the procedure discussed in this chapter overlap with certain considerations in other procedures. It is recommended that the land use evaluation be performed both before and after completion of the other procedures. The initial evaluation of land use will aid in selecting alternative sites; and more objective land use impacts can be more easily identified after completion of the other procedures.

The initial data required for the land use evaluation procedure are estimates of the magnitude of the training to be conducted, the land area required, and the existing land use. The magnitude of activity -- e.g., numbers of troops or vehicles involved and the number of days the area will be used -- can be estimated through coordination with training personnel and examination of applicable TOEs and ARTEPs. The land area required can be determined using estimation techniques provided in TC 25-1.[9] Many FE offices have information which should be considered when studying existing land uses. Major sources of information include the Installation Master Plan, Land Management Plan, Endangered Species Inventory, and Historic/Archeologic

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[9] In addition to providing techniques for estimating training land requirements, TC 25-1 also suggests considerations for identifying certain unusable land; see p 31 of TC 25-1.

Resources Management Program. However, these sources are not exclusive. Any source which identifies the location of sensitive, fragile, and unique land uses or areas should be consulted.

There are four general types of land uses or areas which might be considered incompatible with tactical vehicle use:

1. Areas where the mission, security, and operation of the installation or other training functions would be adversely affected; e.g., explosive ordnance storage and active bivouac or camouflage training areas.

2. Areas which should not be used because of existing or adjacent land uses; e.g., areas adjacent to housing or administration offices.

3. Areas where tactical vehicle maneuvers would be unsafe for training exercise participants or nonparticipants; e.g., abandoned ordnance impact areas and active nonmechanized training sites.

4. Areas which have been identified as, or are suspected to be, historically/archeologically significant, fragile land, critical natural resource areas.

For most proposed tactical vehicle training activities, land uses in the first two categories will generally be avoided as a matter of operational procedure. Land areas in the latter two categories should also be considered potentially incompatible.

Evaluative Procedure

Table 1 lists several examples of land uses which are or may be incompatible with tactical vehicle training. Table 1 also provides conditions, either existing or created by tactical vehicle use, which should be considered when examining a proposed site for land use incompatibility. Table 1 is not all-inclusive, and any land use which uniformly exhibits, or could be affected by, one or more of the conditions should also be considered potentially incompatible.

To determine the suitability of proposed and alternative training sites, all existing land uses in and immediately adjacent to each site should be identified and listed. Future land use, as noted in installation and local land use plans, should be considered. The lists are then compared to the land uses and conflict conditions on Table 1. If any land use on the lists corresponds to one on Table 1, or if it exhibits or may be affected by any of the conflict conditions, it can be considered a potentially incompatible land use.

The next step is to assign a degree of incompatibility to each potentially incompatible land use. This will require some experience in predicting the land use impact which might be anticipated as a result of tactical vehicle training. Installation personnel with experience in natural resource or training lands management will be able to assist in estimating potential impact. Their input can be obtained through coordination meetings. An

Table 1

Land Uses and Areas Incompatible With Tactical Vehicle Training

Examples of Land Uses Which Conflict With Tactical Vehicle Training (By Category of Conflict)	Conditions Which Place Land Uses in Conflict
Mission and Operation of Military Functions	
Land Uses	Conflict Conditions
Active bivouac areas	Live fire
Active nonmechanized training areas	National security
Airfield aprons & approach zones	Personal safety of Army personnel
Demolition areas	Quantity-distance limits
Explosives storage	Unexploded ordnance
Impact areas	
Motor pools	
Ranges	
Incompatible Existing Land Uses	
Land Uses	Conflict Conditions
Administrative areas	Aesthetics
Campgrounds	Air emissions
Churches	Dust
Family housing	Encroachment
Hospitals	Erosion
Industrial sites	Noise
Libraries	Personal safety of personnel
Outdoor theaters	Property damage
Outdoor recreation sites	Siltation
Schools (military and dependent)	Traffic congestion
Troop housing	Turbidity
Transportation corridors	Vehicle operation
Exercise Participant and Nonparticipant Safety	
Land Uses	Conflict Conditions
Active bivouac areas	Live fire
Active landfills	Loose surface materials
Active nonmechanized training areas	Moving tactical vehicles
Demolition areas	Steep slopes
Explosives storage	Traffic congestion
Impact areas	Unexploded ordnance
Outdoor recreation	Water quality
Potable water storage	
Quarries and mines (active and abandoned)	

Table 1 (Cont'd)

Natural and Other Resource Locations

Land Uses	Conflict Conditions
Agricultural/grazing outleases	Aesthetics
Archeological sites	Air emissions
Breeding, migration, or nesting areas	Animal harassment
Cemeteries	Dust
Food plots and feeding areas	Encroachment
Historic sites and structures	Human presence and disruption
Paleontologic sites	Noise
Petroglyphs	Petroleum spills
Rare, endangered, or threatened plants, animals, and fish	Siltation
Scenic areas	Soil compaction
Small watersheds	Soil erosion
Timber plantations	Turbidity
Waterbodies	Vegetation damage
Wetlands	

additional source for land use impact information is the Environmental Impact Computer System (EICS).[10] EICS can be used to obtain a general idea of any potential impact of tactical vehicle training on land use.*

The rating system on Table 2 can be used to assign degrees of incompatibility to land uses. The system is specifically designed for comparison of alternative sites. However, it may be used to stimulate the thoughts of personnel evaluating the impact of a single site.

To assign degrees of incompatibility, the potential effect statements on Table 2 should be considered. Each potentially incompatible land use should be given the rating of that potential effect statement which most closely corresponds to the anticipated impact on the land use. The following paragraphs further explain the potential effect statements and the procedure.

Minimal or No Identifiable Effect on Land Use

Any existing or planned land use on or next to a proposed site would receive a potential effect rating of 1 for either of two reasons. (1) The land use is not identified as incompatible. This would be the case if it is not listed in Table 1 and does not exhibit, or would not be adversely affected by, any of the conflict conditions listed in Table 1. (2) There is no easily identifiable impact to the land use.

[10] R. Riggins and E. Novak, Computer-Aided Environmental Impact Analysis for Mission Change, Operations and Maintenance, and Training Activities: User Manual, Technical Report E-85/ADA022698 (CERL, February 1976).

* EICS information can also be applied to predicting the impact on other elements of the environment. It also suggests mitigation procedures.

Table 2

Rating Scale for Land Use Evaluation

Potential Effect of Training on Land Use	Rating
Minimal or no identifiable effect of land use or the land use is not considered incompatible.................	1
Small effect on land use, but generally only during the training activity..................................	2
Small to moderate effect on land use, both during and after training activity, but will not cause a significant change in land use.........................	3
Moderate to significant effect on land use; training may deteriorate the quality of the land use or induce a change in land use.............................	4
Very significant effect on land use--to the extent that certain natural resources of the land are destroyed and recovery time would be greater than 20 years or that the land use is totally changed...................	5

Few, if any, lands would not be affected by tactical vehicle training. However, certain land uses next to a proposed site would receive minimal or no impact. Examples include unimproved lands (i.e., lands containing no significant manmade structures), impact areas, ranges, landfills, and quarries.

Small Effect on Land Use

A rating of 2 should be given if the impact to a land use would be small. Again, few, if any, lands which are actually used for tactical vehicle maneuvers would receive a small impact. Certain adjacent land uses, however, may receive only a small impact; for example, activities at adjacent active bivouac, nonmechanical training, or outdoor recreation areas. The possibility of encroachment on timber plantations or agricultural/grazing outleases is also a small impact which would receive a rating of 2.

Small to Moderate Effect on Land Use

A small to moderate effect on land use would result in a potential effect rating of 3. This rating implies that there will be an effect on the land use but that this effect will not cause an actual change in the land use. This rating may apply to lands actually used for tactical vehicle training if certain conditions are applicable. For example, if the site being examined is unimproved land which will not be modified through any operations such as clearing, and if the site will only be used occasionally for small unit training, it may receive a rating of 3. This rating can be given even though the actual land use is changed from unimproved land to training area.

For adjacent lands, a primary consideration is whether the land use is changed as a result of tactical vehicle training. Noise, dust, or human activity can affect wildlife in adjacent breeding, nesting, feeding, and migration areas. However, if the disturbance is not too great and lasts only a short time, wildlife will generally resume these activities after training exercises. Therefore, although affected, land use does not change. Similarly, increased traffic to and from training sites might create congestion along transportation corridors, but the corridors themselves will not change. Such impacts would be considered small or moderate.

Moderate to Significant Effect on Land Use

A potential effect rating of 4 is given if there is a moderate to significant deterioration in the quality of land use, or if land use change is induced. This rating would generally apply to the actual land used for training if the land is unimproved and has no particular environmental significance and the exercises involve fairly large numbers of vehicles with training conducted on a regular basis. Environmentally significant areas are archeological/paleontologic sites; wetlands; scenic areas; breeding, migration, or nesting areas for locally important species; and areas containing rare, endangered, or threatened plants, animals, or fish.

Adjacent land uses which would receive a rating of 4 are those which are generally improved; i.e., they contain structures such as houses, hospitals, and offices. These uses can be affected by noise and dust from tactical vehicle maneuvers. Increased vehicle traffic to and from the training site, creating traffic congestion, would also affect these uses, particularly residential land use.

Another consideration in giving this rating is the relative location of the improved land use. Considerable controversy and negative publicity could develop if the adjacent improved land use were off-post. Therefore, off-post improved land uses of this type should receive a higher rating.

Very Significant Effect on Land Use

A very significant effect on land use would be anticipated if the land proposed for use contained existing facilities (e.g., housing and explosives storage), or environmentally sensitive conditions and significant resources (e.g., historic sites and rare, endangered or threatened species). Any proposed site containing these or similar uses or resources should be rated 5. Even if the proposed site contains no such facilities or resources or is unimproved, but the numbers of vehicles involved, the level of activity, and duration of use are considerable, the land actually proposed for use should receive a rating of 5.

Adjacent, improved land uses, particularly those in the incompatible category on Table 1, should receive a rating of 5 if the training activity proposed for the site is considerable. Large-scale tactical vehicle maneuvers adjacent to these and certain other land uses might generate enough noise and dust to seriously reduce the quality of the land uses. This might induce a total land use change.

Use of Rating System

The following example offers further explanation of the use of the rating system and evaluative procedure.

Suppose that a proposed site for fairly extensive maneuvers contains two types of land use: unimproved land and a tract of land suspected to be historically/archeologically significant. Since the training is extensive and to be conducted regularly these land uses might receive potential effect ratings of 4 and 5, respectively. Further assume that the proposed area is bounded by eight land uses: unimproved land, an active bivouac area, explosive storage, a landfill, a timber plantation, troop housing, outdoor recreation, and a prime wildlife breeding, migration, and nesting area. Considering the type and intensity of training to be conducted, these land uses might receive potential effect ratings of 1, 2, 2, 1, 2, 4, 2 and 3, respectively.

After land uses in and next to a proposed site have been rated, their rating values are added. For the example, the total is 26. This total value is then divided by the number of land uses which received ratings. In the example, 26 is divided by 10 for a value of 2.6. This final value is a quantitative measure of the potential effect of tactical vehicle training on land use and can be used to compare alternative sites. The site with the lowest value is more acceptable for training than the other sites.

Once this value has been calculated, the most significant land use limitations should be identified and recorded. This information will be useful in selecting mitigation procedures. Land uses which represent limitations on the use of a particular site are those that received the highest potential effect ratings. In the example, the presence of suspected historical/archeological sites on the proposed site is the most significant limitation. The adjacent location of troop housing and an important wildlife breeding, migration, and nesting area are also significant limitations. When choosing impact mitigation procedures, the relative location of these limiting land uses should be carefully considered.

Mitigation Procedures

Three basic actions can be taken to control the effects of tactical vehicle training on land use. The first, and perhaps most effective, is to adjust the boundaries of the proposed training area so that sensitive or incompatible land uses are not located in or next to it. At a minimum, buffer zones which are off-limits to vehicles could be established around the training area. Any sensitive or incompatible land use in the middle of the training area could also be declared off-limits. The second action is to ensure that the other mitigation techniques suggested to reduce the impact of training on other environmental resources are indeed implemented. The third basic action is to reduce the scope of the training activity to be conducted.

These steps may be taken alone; but generally, a combination of actions will prove to be most effective. Installations should make sure that mitigation actions do not hinder the goals of the training mission.

4 NOISE

Noise Considerations

Noise generated by tactical vehicle training can have a significant environmental effect. Many activities and land uses are "sensitive" to excessive noise levels. For example, classroom or hospital activities can be seriously disrupted by nearby tactical vehicle movement or training. Two types of noise should be considered when areas are evaluated for tactical vehicle training: that generated by weapons firing (blast noise), and that generated by vehicles while en route to maneuver areas and during maneuvers.

Noise levels generated by weapons firing depend on a number of factors and can be quite variable. To mitigate the effect of blast noise, distances of up to 3 mi (5 km) around a proposed training area may be necessary for noise buffer zones. When large numbers of weapons are involved, distances of concern may extend to 7 or 10 mi (11.66 or 16.66 km).[11] If noise-sensitive land uses are in these zones, a proposed site may not be acceptable. Techniques to evaluate the potential effect of blast noise can be quite complicated. At a minimum, noise contours must be developed. Information and techniques for development of these contours and further evaluation of blast noise can be obtained from Technical Manual (TM) 5-803-2, and the appropriate agencies it lists.

The evaluative procedure provided in this chapter can be used to evaluate noise generated by tactical vehicle movement.* The primary considerations for evaluating tactical vehicle noise are the numbers and types of vehicles to be used in the training exercise, the average speed at which they will be traveling, the maximum acceptable noise levels for sensitive land uses and the distances of these uses from the noise source. Other considerations are the noise levels generated by the vehicles and the type of training or maneuvers to be conducted.

Information on the numbers and types of vehicles can be obtained through coordination with training personnel and examination of applicable TOEs and ARTEPs. These sources will also be useful in identifying the type of training to be conducted. The distances of noise-sensitive land uses from a proposed training area or route can be figured with land use or topographic maps. Table 3 lists maximum acceptable equivalent sound level (L_{eq}) requirements for various noise-sensitive land uses.

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[11] Environmental Protection: Planning in the Noise Environment, Technical Manual (TM) 5-803-2 (DA, 15 June 1978), p 3-28.

* The procedure only applies to noise generated by tactical vehicle movement. As suggested earlier, consult TM 5-803-2 for information and techniques related to blast noise. Another source for procedures to evaluate the noise impact is R. J. Goff and E. W. Novak, Environmental Noise Impact Analysis for Army Military Activities: User Manual, Technical Report N-30/ADA047969 (CERL, November 1977).

Table 3

Maximum Acceptable Equivalent Sound Level (L_{eq}) Requirements for Selected Land Uses*

Land Use	Maximum Acceptable Sound Level (in dBA)
Agricultural (except livestock)	80
Bachelor housing	65
Campgrounds and picnic areas	65
Classrooms, libraries, and churches	65
Commercial and retail stores, exchanges, movie theaters, restaurants, and cafeterias, banks, credit unions, enlisted officer clubs	70
Dental clinic, medical dispensaries	70
Family housing	65
Flight line operations, maintenance, and training	80
Gymnasiums, indoor pools	70
Hospitals, medical facilities, Nursing homes (24-hour occupancy)	65
Industrial, manufacturing, and laboratories	70
Livestock farming, animal breeding	75
Neighborhood parks	70
Offices and administration buildings -- military	70
Offices -- business and professional	70
Outdoor music shells, outdoor theaters, and cultural events	65
Outdoor sports arenas, outdoor spectator sports	70
Playground, active sport recreational areas	70
Transient lodging -- hotel, motel, etc.	65
Troop housing	65

* Adapted from TM 5-803-2, Figure 4-5.

Table 3 was adapted from Figure 4-5 in TM 5-803-2.[12] The sound level requirements shown on Figure 4-5 of the TM assume that a new facility is to be constructed in an existing noise environment. Table 3 assumes that a new noise-generating land use is being developed next to an existing facility or land use. Therefore, some modification in the requirements was necessary. It was impractical to list all noise-sensitive land uses on Table 3; any land use suspected to be noise-sensitive should be put in a category which seems appropriate.

Once all variables have been identified and the following procedure applied, the user will have determined the Distance Necessary for Noise Attenuation (DNNA) for each noise-sensitive land use. DNNAs are distances

[12] TM 5-803-2, p 4-24.

that tactical vehicle maneuver areas or routes should be located from noise-sensitive land uses in order to meet maximum acceptable noise-level requirements.

Evaluative Procedure

The procedure used to evaluate vehicle noise impact and determine DNNAs considers vehicle movement during maneuvers and movement to and from maneuver areas. The distinction between the two is the number of passes that vehicles will make during a training day and the time during which these passes might be made. Vehicles involved in maneuvers may pass by lands adjacent to the training area many times during the period in which training is conducted, generally the entire day. Vehicles en route to and from a training area will generally pass along the access route twice during a day.

To simplify the explanation of the evaluation procedure, a hypothetical example is included with the following discussions. For this example, assume that a proposed tactical vehicle training area is needed for extremely large exercises that involve 50 tanks, 30 tracked transport vehicles, 30 heavy trucks (vehicles that are diesel-powered and have three or more axles), and 20 medium trucks (six-wheel vehicles that are gasoline-powered and have three or more axles). Further assume that while en route to the training site and during the exercise, all of these vehicles will travel at an average speed of 30 miles per hour (mph) (50 km/hr). For the maneuver area evaluation assume that all vehicles will pass along the boundary of the proposed training area once every hour. For the access route, assume all vehicles will pass by twice during the day, once to and from the training area. Also assume that each pass will be completed within 1 hour.

In the first assumption, the user can substitute actual numbers and types of vehicles to fit the situation. The numbers provided in the example are fairly large and were chosen only to provide a means to illustrate the procedure. Generally, the numbers of vehicles involved in unit training will be much smaller than the example. However, if several units are training simultaneously, these numbers may be reached. The assumption concerning speed is obviously very general and may not represent realistic movement and training maneuvers. However, an estimate of speed is required to perform the evaluation. The user can adjust the speed assumption to fit the situation. If experienced training personnel feel the vehicles will average 20 mph (33.3 km/hr) during maneuvers, the speed can be modified accordingly.

The maneuver area assumption that all vehicles will pass by the boundary of the training area may also seem unrealistic. However, it too is required for the evaluation procedure since details about vehicle use in a new training area may not be available. The assumption that all vehicles will pass by along the access route may be modified if vehicles are to be left at the training site. Those actually used en route to and from the training area need to be considered.

Regardless of the general assumptions, the procedure described here will yield useable results. This is especially true for comparison of alternative training sites and routes. Based on the assumptions, the procedure may yield fairly generous estimates of the DNNA. If the most acceptable site is chosen and appropriate mitigation procedures are implemented, these generous distances should ensure that maximum acceptable sound levels are not exceeded.

Vehicle Movement in the Training Area

The first step in the procedure is to determine which group of vehicles, by type, has the greatest noise impact. This is done with nomographs provided in TM 5-803-2 and reproduced here as Figures 1 and 2.[13] To use these nomographs, complete the following steps for each type of vehicle -- i.e., heavy trucks, medium trucks, weapons vehicles (e.g., tanks) and transport vehicles (tracked). (Using the numbers in the hypothetical example, the appropriate steps for tanks and heavy trucks have been illustrated on Figures 1 and 2.)

Step 1. Draw a line from the pivot point through the estimated average speed for each vehicle type and to line A.

Step 2. From the intersection point on line A, draw another line to that point on the vehicle per hour scale, V (located on the far right of the nomograph), which represents the number of vehicles which will pass by the training area boundary. (Use 10 times the number for medium trucks.) With reference to the earlier assumption, this means the total number of vehicles of each type to be used in the proposed training area. Should the number of a certain type of vehicle not be represented on the nomograph, e.g., 10 heavy trucks (Figure 2), the noise impact for this type of vehicle and volume may be considered negligible compared to the effects of other noise. These vehicles and volumes can be dropped from further consideration in the procedure.

Step 3. From where the line drawn in Step 2 intersects line B, draw another line to the 50-ft mark on the scale labeled D_o (distance to observer).

The intersection point of the third line with the L_{eq} dB (decibel) scale represents the equivalent sound level generated by that number of that type of vehicle if the observer were 50 ft (15.24 m) from where the vehicles pass. Comparison of these levels for each vehicle determines the group of vehicles that has the greatest noise impact. For the hypothetical example, 20 medium trucks, 30 heavy trucks, 30 transport vehicles, and 50 weapons vehicles generate 56, 71, 79, and 85 dB L_{eq}, respectively. Therefore, the 50 tanks would generate the greatest noise impact.

The next step is to determine how far away the passing vehicles with the greatest noise impact (50 tanks) have to be so that sound levels do not exceed acceptable requirements: 65, 70, 75, or 80 dB L_{eq} (Table 3). The L_{eq} nomograph for the vehicle with the greatest impact is used to figure this. The intersection of the line drawn in Step 2, above, with the line labelled B is the reference point. From that point, the user should draw lines which pass through the L_{eq} scale at those levels which represent the four L_{eq} requirements. (The lines for the 50 tanks in the example have been illustrated on Figure 1.) These lines should be extended to pass through the D_o scale. The points at which these lines intersect the D_o scale show how far from an observer, or noise-sensitive land use, the vehicles must pass so that noise levels do not exceed the four sound level requirements.

[13]TM 5-803-2, pp 3-37 and 3-38.

For example, as shown by Figure 1, 50 tanks, traveling at 30 mph (50 km/hr), must pass at 900 ft (274.5 m) for the noise level not to exceed 65 dB L_{eq}. In order not to exceed 70, 75, and 80 dB L_{eq}, the 50 tanks must pass by

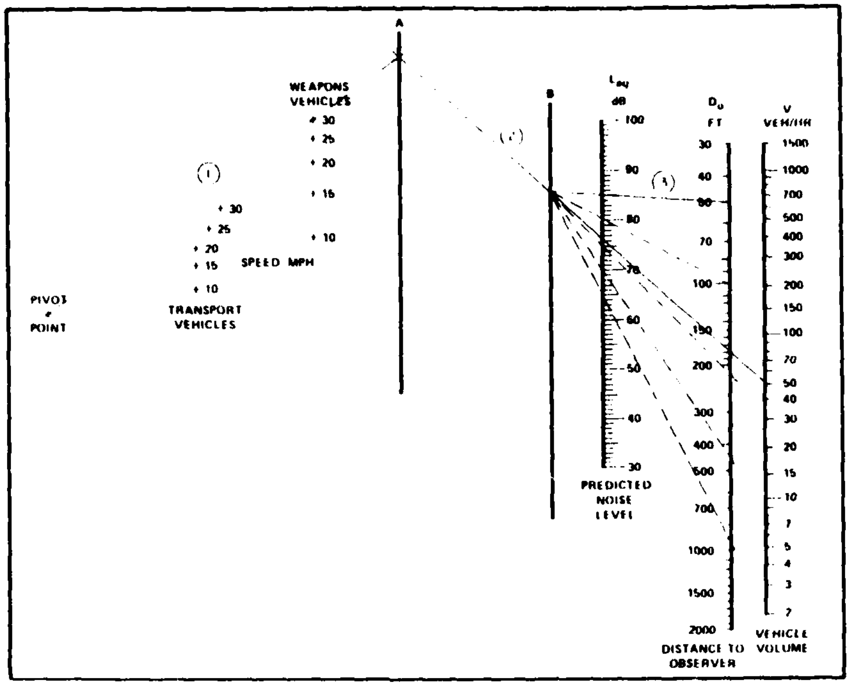

Figure 1. L_{eq} nomograph for weapons and transport vehicles.

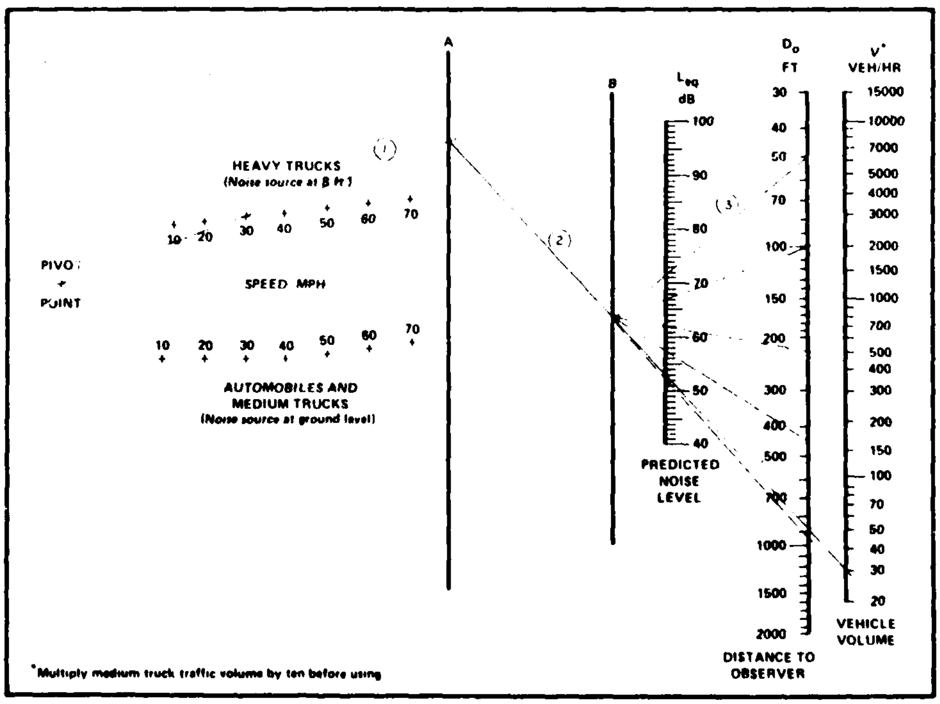

Figure 2. L_{eq} nomograph for heavy and medium trucks.

at distances of 450 (137 m), 225 (68.6 m). and 100 ft (30.5 m), respectively. These distances only represent DNNA requirements for the vehicles with the greatest noise impact. When other vehicles pass by with these vehicles, the noise levels generated by the vehicle movement may be increased.

The next step is to determine the equivalent sound levels generated by the other vehicles as they pass by at the DNNAs for the vehicles with the greatest impact, and then correct the DNNAs to account for the increased noise. To do this, the equivalent sound levels generated by the other types of vehicles, as they pass by at each DNNA for the vehicles with the greatest impact, are added. These noise levels are then added to each appropriate maximum equivalent sound level requirement. The differences between the solutions to these final additions and the actual noise level requirements are then used as correction factors to establish the total DNNA for each noise level requirement.

To determine the equivalent sound level generated by the other vehicles, as they pass by at the various DNNAs for the vehicle with the greatest noise impact, lines are again drawn on the nomographs. These lines are drawn for each of the other vehicles and for each previously established DNNA requirement, e.g., 900 (274.5 m), 450 (137 m), 225 (68.6 m), and 100 ft (30.5 m). The intersection points of the lines drawn in the earlier Step 2 with each line B are again used as reference points. Lines are drawn from each point B to each DNNA requirement for the vehicle with the greatest impact. For example, on the heavy truck nomograph on Figure 2 lines have been drawn from the intersection point on line B to the 900 (274.5 m), 450 (137 m), 225 (68.6 m), and 100 ft (30.5 m) marks on the D_0 scale. The intersections of these lines with the L_{eq} scale identify the L_{eq} noise levels generated by the 30 heavy trucks as they pass by at the various distances.

As illustrated, 30 heavy trucks passing by at distances of 900 (274.5 m), 450 (137 m), 225 (68.6 m), and 100 ft (30.5 m) would generate L_{eq} sound levels of 52, 58, 62, and 67 dB, respectively. Using the transport vehicle nomograph, 30 tracked transport vehicles passing by at 900, 450, 225, and 100 ft would generate 59, 64, 69, and 75 dB L_{eq}, respectively. For 20 medium trucks the noise level at 900 ft (274.5 m) is less than 40 dB L_{eq}. Levels lower than 40 dB L_{eq} are not considered since their impact on the ambient noise level is negligible. At 450 (137 m), 225 (68.6 m), and 100 ft (30.5 m), the noise level generated by the passing of 20 medium trucks is 42, 47, and 52 dB, respectively.

Table 4 and Figure 3 illustrate a simplified method to add decibel levels. Table 4 is reproduced from Figure 2-1.2a in TM 5-803-2 and Figure 3 has been adapted from Example 2-1.2b of the TM.[14] Note that noise levels must be arranged in ascending order for correct addition.

In the example, the combined noise level of medium trucks, heavy trucks, and transport vehicles at 900 ft (274.5 m) is 60 dB L_{eq}; i.e., the noise level generated by medium trucks is less than 40 dB and the difference between anything less than 40 dB and 52 dB is greater than 10 dB so the sum would be 52 dB; and the difference between 52 dB and 59 dB is 7 dB, so 1 dB should be added to the highest noise level to identify the total equivalent sound level

[14]TM 5-803-2, p 2-5.

Table 4

Method for Addition of Sound Levels

When Two Decibel Values Differ by:	Add the Following to the Higher Value:
0 to 1 dB	3
2 to 3 dB	2
4 to 9 dB	1
10 or more dB	0

Note: To add more than two levels, start with lowest value

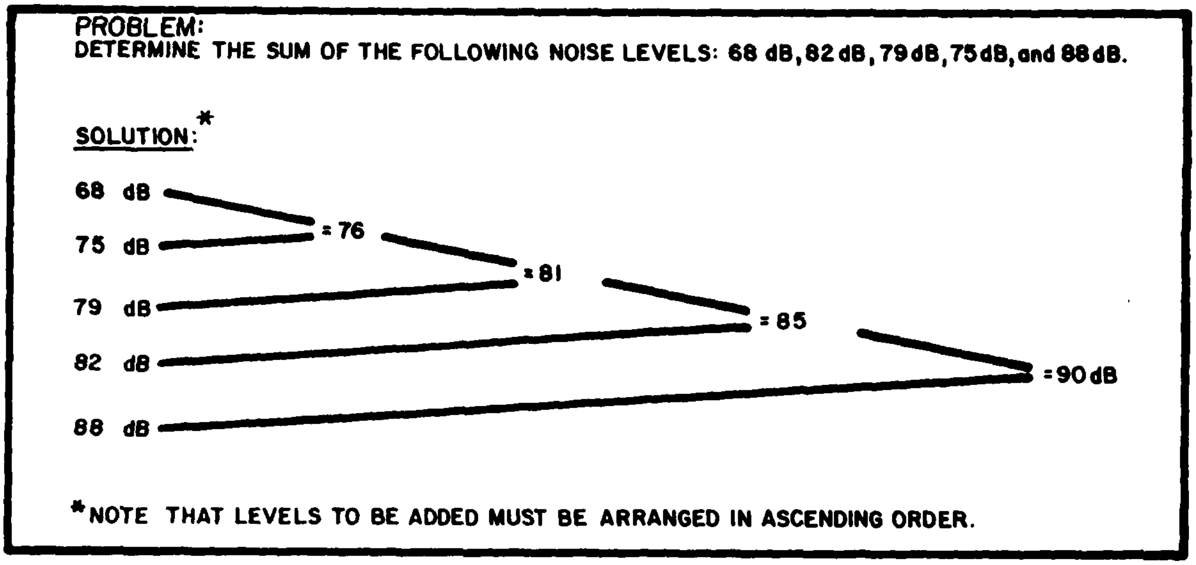

Figure 3. Simplified decibel addition.

(Table 4). The combined noise levels for the three types of vehicles at 450 (137 m), 225 (68.6 m), and 100 ft (30.5 m) are 65, 70, and 76 dB L_{eq}, respectively.

Once combined noise levels generated by the other vehicles are determined, identifying the distance correction factors is fairly simple. First, the combined levels are added to each appropriate noise level requirement. For example, at 900 ft (274.5 m), 50 tanks generate the maximum acceptable noise level of 65 dB L_{eq}. At 900 ft (274.5 m) the other vehicles in the hypothetical example generate 60 dB L_{eq}. Therefore, all vehicles will generate a noise level of 66 dB L_{eq}. That is, the difference between 60 dB and 65 dB is 5 dB so 1 dB is added to 65 dB to establish the total equivalent sound level. At 450, 225, and 100 ft (137, 68.6, and 30.5 m), the total noise levels for the hypothetical vehicle movement will be 71, 76, and 81 dB L_{eq}, respectively.

The DNNA correction factors are the differences between these total noise levels and the noise level requirements. In the example, the correction factor for each DNNA requirement is 1; i.e., 66 minus 65, 71 minus 70, 76 minus 75, and 81 minus 80 all equal 1. Once these factors are known they are used, in conjunction with the information provided on Table 5, to determine the DNNAs for the noise generated by the movement of all vehicles. From Table 5, the appropriate DNNAs for the hypothetical example are 1035, 518, 259, and 115 ft (315.6, 157.9, 78.9, 35 m). The vehicles involved in the exercise must pass no closer than these distances to avoid exceeding maximum acceptable equivalent sound level requirements of 65, 70 , 75, and 80 dB L_{eq}, respectively.

Once the DNNA for each maximum acceptable L_{eq} requirement has been determined, all land uses near the proposed training area should be identified. Their sensitivity to noise and location relative to the proposed vehicle training area will determine the area's suitability for use. For example, suppose that troop housing is near a proposed maneuver area and that the vehicles which will use this area are of the same numbers and types of vehicles described in the example (p 24). Since the maximum acceptable L_{eq} requirement for troop housing is 65 dB (see Table 3), the training area is unsuitable if the troop housing is within 1035 ft (315.6 m). If the troop housing is farther than 1035 ft (315.6 m) from the area, then relative to vehicle movement noise the site is suitable, provided it does not conflict with other noise-sensitive land uses. (Note again, that this procedure does not consider blast noise.)

Table 5

Correction Factors for the Distance
Necessary for Noise Attenuation

If the Correction Factor Is:	Multiply the DNNA for the Loudest Vehicles by:
1	1.15
2	1.31
3	1.50
4	1.72
5	1.97
6	2.25
7	2.58
8	2.96
9	3.38
10	3.88

The applicable DNNAs for each noise-sensitive land use near a proposed training area should be identified. If any land use is less than the applicable DNNA, maximum acceptable noise levels may be exceeded. The land uses which may be affected in this manner become limitations on the use of the area. If alternative areas are being considered, the area with the least noise conflict is the most acceptable. That is, the area with the least number of adjacent noise-sensitive land uses, or amount of noise-sensitive acreage, which might be affected by tactical vehicle training should receive first consideration as a use area. The types of land use which might be affected should also be considered. Noise conflicts with housing will certainly generate more controversy than conflicts with agricultural land use. Regardless of the type of land use, all potential noise conflicts should be identified and the appropriate information transferred to the decision maker.

Vehicle Movement Along Access Routes

With modification, the procedure described above is used to determine potential noise conflict along proposed access routes. This modification is in the numbers of vehicles used as the vehicle volume in Step 2 of the initial stages of the procedure (p 25). This modification is necessary for two reasons: (1) all or a portion of the access route may be used by other traffic. For evaluation results to be accurate, the vehicle volumes or noise levels generated by tactical vehicle movement should be added to these traffic volumes or their noise levels; (2) the principles of equivalent sound level and the volume conditions with which the L_{eq} nomographs in Figures 1 and 2 were developed also make this modification necessary.

Briefly described, equivalent sound levels are levels of constant sound with the same sound energy as a time-varying sound. These levels are determined by averaging sound levels over time. The averaging of sound levels was a consideration in the development of the nomographs. In addition, they were developed for peak hour volumes and assumed relatively steady traffic volumes. However, this development makes the nomographs more applicable for use in evaluating relatively steady traffic volumes occuring over an entire day.*

Tactical vehicles usually travel along routes to and from training areas during two hours of the day. Therefore, the numbers of vehicles used as vehicle volume should be reduced to reflect steady volume as an average over time. This is done by adding the number of vehicles in each pass and dividing by 24 (hours in the day). This calculation results in the number of vehicles which should be used to represent the tactical vehicle volume. If any passes occur between 2200 hours and 0700 hours, a penalty should be added for nighttime operation. This is done by multiplying the number of vehicles in each nighttime pass by 10, adding this figure to the number of daytime vehicle passes, and dividing by 24.

In the hypothetical example (p 24), the vehicle volumes for tactical vehicles along an access route (two passes) used during daytime hours would be four weapons vehicles ($50 \times 2 \div 24 = 4.2$ or 4), three track transport vehicles, three heavy trucks, and two medium trucks. These reduced numbers of vehicles are used in Step 2 of the initial stages of the evaluation procedure

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* Consult TM 5-803-2 for a technical discussion of the principles of L_{eq} and the development of the nomographs.

described for maneuver areas (pp 25-30). Remember that vehicle volumes for other traffic along the access route must be included in the procedure.

By completing the rest of the steps in the procedure as described, DNNAs for access routes are identified. Once this is done, the considerations for acceptability of access trails are the same as those for maneuver areas.

Mitigation Procedures

The most basic mitigation technique for reducing noise level impact is site selection. With the evaluative procedure described in this chapter, proposed site or route location boundaries can be adjusted and alternative locations recommended. Once DNNAs for each noise-sensitive land use have been identified, they can be marked on a base map. Lines are drawn around each noise-sensitive land use at that distance, corresponding to the scale of the map, which illustrates the minimum distance outside which the proposed training area should be located (the DNNAs). The areas between these lines and the noise-sensitive land uses are noise buffer zones. The acreage in these zones, as well as the acreage in the noise-sensitive land uses, should be eliminated from considerations as training areas or routes. Appropriate sites can be chosen accordingly.

Several other actions and techniques are recommended to reduce the impact of tactical vehicle noise. Chapter 5 of TM 5-803-2 provides a detailed description of many of these mitigation procedures.[15] Proper route configuration and design, construction of noise reduction barriers, vehicle maintenance, and control of vehicle speed and numbers are the most commonly recognized procedures. Each of these is effective, particularly along routes to and from training areas.

The effectiveness of controlling vehicle speed and volume to reduce noise is illustrated in Figures 1 and 2. Methods for achieving this reduction would include scheduling and speed limits. Movement to a training area might be scheduled over a period of several hours. This would reduce the volume over a 1 hour period and lessen the impact on equivalent sound levels. The speed at which vehicles travel directly relates to the noise they generate. To reduce noise levels, installations might establish speed limits along routes to training areas. Appropriate speed limits can be determined with the nomographs. To do this, use a lower estimated average speed for the vehicles (lower than that which was actually estimated in the original evaluation), and complete the evaluation procedure as described. Calculations using the lower speed will result in shorter DNNAs. If potential noise-sensitive land uses are no longer located closer than this new DNNA, then a speed limit might be established at this new estimated average speed. Limits need not be in effect along an entire route but should be established where vehicle movement might conflict with noise-sensitive land uses.

Maintenance and driver awareness are other, less effective, mitigation techniques related to vehicle operation. Proper maintenance of vehicles can significantly contribute to reducing noise levels. Drivers should be made aware of the potential noise conflict their vehicles can create.

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[15]TM 5-803-2, pp 5-1 through 5-68.

Route design can help reduce noise levels: steep grades and stop and go movement can be eliminated; natural terrain can act as a sound barrier. Steep grades and stop and go traffic require vehicles to change gears to increase, decrease or maintain speed. Engine noise generated by these actions can greatly contribute to the total sound level of the vehicle's movement. Sound barriers are very effective in reducing the noise levels that would affect noise-sensitive land use. In addition to natural barriers, artificial barriers could be built along route segments which are particularly sensitive to noise.*

* TM 5-803-2 provides considerable information on the use of sound barriers.

5 TERRAIN

Terrain Considerations

In this report, "terrain" refers to the land's physical features, such as topography (slope), vegetation cover, ground stability, and area covered by surface water. Certain non-landform physical characteristics of areas, such as the water table, are also considerations. Since simulation of combat conditions is the purpose of field maneuvers, any use restrictions owing to terrain may be somewhat limited. However, an examination of certain physical features at a proposed or alternative training site is strongly recommended.

There are two principal reasons for considering terrain characteristics when selecting a tactical vehicle training area.

1. Environmental protection. For example, tactical vehicle movement over steep slopes will remove vegetation, which exposes the soil and increases the potential for erosion. The severity of impact caused by erosion will depend upon the degree of slope on which the exposed soil is located.

2. Training efficiency. Proper consideration of terrain characteristics will aid in the selection of an area which simulates combat conditions. This will reduce the need for site preparation, (e.g., clearing) and reduce delays before using the area. In addition, certain terrain characteristics are unsuitable for tactical vehicles. For example, trafficability studies indicate that vehicles in the category which includes most all-wheel-drive trucks, a great number of trailed vehicles, and heavy tanks generally have less than a 50 percent chance of travelling up slopes of 45 percent in areas where the water table is at a depth of less than 4 ft (1.22 m) and the soils have a high moisture content.[16] Consideration of terrain can therefore reduce the need to rescue stranded vehicles.

The following discussion is divided into subsections identifying suitable and unsuitable terrain characteristics which should be considered. Figure 4 summarizes this information. Although characteristics are identified as suitable and unsuitable and recommendations are made, these should not be considered absolute limitations or conditions for use. They are provided as general considerations only.

Actual conditions for use will depend on the type of training required. If proposed training activities require the use of unsuitable terrain, areas should be provided for this use. However, environmental damage in areas with certain unsuitable characteristics -- e.g., marshes -- may be considerable. As a result, areas with environmentally unsuitable terrain should be as small as possible and chosen with intensive use in mind; every effort should be made to provide mitigation for the environmental impacts of use.

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[16] Trafficability of Soils: Soil Classification, Technical Memorandum No. 3-240, Sixteenth Supplement (U.S. Army Engineer Waterways Experiment Station [WES], August 1961), Table 14.

GENERAL TERRAIN CONSIDERATIONS

When Terrain Characteristics Are Evaluated For Possible Tactical Vehicle Use, Areas May Be Considered Generally

UNSUITABLE IF:	SUITABLE IF:
1. The average degree of slope normally exceeds 30 to 50 percent.	1. The average degree of slope or maximum slope does not normally exceed 30 to 35 percent.
2. They are low-lying areas; e.g., bottomlands, which are seasonally wet.	2. They are upland areas with few streams and water bodies.
3. They contain vegetation resources which are valuable and highly susceptible to damage.	3. They contain vegetation resources of average or lower value and low susceptibility to damage.
4. They will require considerable site preparation; e.g., clearing.	4. They will require a minimal amount of site preparation.
5. They have already been very severely damaged.	5. They have already been damaged, but not too severely.
6. They contain many large boulders.	6. They have gravelly and/or stony surfaces.
7. The water table is generally at a depth of less than 4 ft (1.22 m).	7. The water table is generally at a depth of greater than 4 ft (1.22 m).
8. Surface water drainage is somewhat poor to very poor.	8. Surfaces are moderate to well drained.

Figure 4. Suitable and unsuitable terrain characteristics.

Evaluative Procedure

To begin the evaluation of terrain characteristics, the user should consult any available source of information about existing terrain in proposed or alternative sites. Obvious sources are topographic maps. Other sources include vegetation surveys, geologic maps, aerial photographs, soil surveys, water table records, well logs, and weather records. Persons who work in the natural resources section of the installation's FE office and who have been on the installation for several years may be able to provide information about an area's physical characteristics. In addition, a site visit by the examiner is recommended.

When as much information as possible has been gathered about a proposed site, the characteristics should be compared with the lists of suitable and unsuitable characteristics. If a proposed area has many unsuitable characteristics, it may be unacceptable for use, and an alternative area should be found. If it contains few unsuitable characteristics, it may be considered acceptable.

This method of evaluation is not as systematic as others provided in this report and relies primarily on coordination and good judgment. It will, however, identify areas for environmental concern. Since the procedure does not provide any quantitative analysis of terrain limitations it is best suited for comparison of alternatives.

*Unsuitable Terrain Characteristics**

Topography. Topography refers to slope, relief, and physical landform. Slope is the change in elevation over distance and is generally expressed in terms of a percentage. For example, a rise of 60 ft (18.3 m) in elevation over a horizontal distance of 100 ft (30 m) represents a 60 percent slope. The average degree of slope found in a proposed area can be determined from topographic maps or with slope measuring instruments.** Based on the ability of tactical vehicles to climb certain slopes and the potential for soils to erode on steeper slopes, areas are unsuitable where the average degree of slope exceeds 30 to 35 percent.

With regard to relief and physical landform, low-lying areas in bottomlands and depressions which are seasonally wet are unsuitable, as are areas with considerable surface water acreage. Such areas generally have soils and vegetation which are easily damaged. Finally, areas with many cliffs, bluffs, and steep slopes with a history of, or potential for, mass wasting (landslides, rockslides, soil slump, etc.) are also unsuitable.

Vegetation. Areas having vegetation resources which are valuable and highly susceptible to damage are unsuitable. (See Chapter 9 for detailed examination of vegetation suitability.) In addition, areas that require considerable site preparation before use -- e.g., clearing -- may be considered less suitable.

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* Considerations and criteria for terrain suitability are based on review of literature, especially WES trafficability and mobility reports and CERL off-road recreational vehicle research (see Appendix C).

**Simple methods for determining slope for topographic maps are provided in various source materials used to prepare this report. See Appendix C, and especially: R. M. Lacey and H. E. Balbach, Evaluation of Areas for Off-Road Recreational Motorcycle Use, Volume II: Alternate Soil Suitability Determination Methods, Technical Report N-86 (CERL, December 1980); William M. Marsh, Environmental Analysis for Land Use and Site Planning (McGraw-Hill Book Company, 1978), p 49; and Soil Survey Staff, Soil Survey Manual, U.S. Department of Agriculture Handbook No. 18 (U.S. Government Printing Office, 1962), p 160.

Surfaces. The most suitable areas for use are often those that are already damaged. However, if this damage is very severe -- e.g., huge gullies and poor vegetation regrowth -- any further use, which would only magnify this damage, should be avoided. Surfaces which contain many boulders may also be unsuitable. These features may act as traps for tanks and other vehicles. Intensive use of trails or pathways around these obstacles can severely damage vegetation and soil. (More detailed discussion of suitable and unsuitable soil surfaces is in Chapter 6.)

Water Table. Information about the water table in a proposed training area can be obtained from well logs or engineering studies of the area. If time permits, a field examination may also be done. Post holes can be dug at various locations on the site; the depth from the land surface to the water level which fills these holes will be the depth to the water table. Generally, areas near water bodies or streams will have high water tables, and areas on upland ridges or slopes will have low water tables. Areas where the average table is less than 2 ft (0.6 m) from the surface are generally unsuitable for use. If the average water table is between 2 and 4 ft (0.6 m and 1.22 m) deep the area is moderately unsuitable.

Drainage is a characteristic which is related to the water table and will also affect the suitability of an area. Areas with somewhat poor to very poor internal and external drainage are unsuitable. Areas with somewhat poor drainage are where water is removed slowly enough to keep the soil wet most of the time and the water table is generally less than 2 to 3 ft (0.6 to 1 m) below the surface. Areas such as marshes, bogs, and swamps have this characteristic and are unsuitable for use.

Seasonal Considerations. Seasonal variations in moisture conditions should be considered when water table, drainage, and soil wetness are assessed. If training is to be conducted year-round, the suitability of training areas, as it relates to water table and drainage, should be based on wet season conditions.

Suitable Terrain Characteristics

Topography. Areas where the average degree of slope or maximum slopes do not exceed 30 to 35 percent can be considered suitable for tactical vehicle training. Depending on soil type, most vehicles will have at least a fair and generally an excellent chance of climbing these slopes without becoming stranded. Upland areas with few streams and water bodies and small degrees of slope are most suitable.

Vegetation. Areas which have vegetation resources of average or lower relative value and low susceptibility to damage are more acceptable for training sites than areas with significant vegetation resources (see Chapter 9). Areas requiring the least amount of site preparation, in terms of vegetation removal, before use will generally have greater suitability. If existing vegetation is maintained, slopes and soils will be more stable and less susceptible to erosion.

Surfaces. Gravelly and stony surfaces are suitable for tactical vehicle training because they are not easily eroded, and vehicles have a high probability of travelling over them without becoming stranded.

Water Table. Areas with seasonally high water tables that are more than 4 ft (1.22 m) from the surface are the most suitable for tactical vehicle training. Moderately to well-drained surfaces are also the most acceptable for training operations. Moderately and well-drained surfaces may be wet for a short time during the year, but this should not affect use.

Once the terrain characteristics of a proposed site or alternatives have been identified and compared with the unsuitable and suitable characteristics discussed above, the user should have an indication of the terrain's suitability. Each unsuitable characteristic in an area should be recorded. This information should be transferred to the decision-maker and identified as a possible environmental concern or conflict. If a proposed area exhibits many unsuitable characteristics, the information above can be used to choose a more acceptable site.

Mitigation Procedures

Alternative site selection and scheduling are procedures to decrease the environmental impact associated with unsuitable terrain characteristics. Sites should be chosen which exhibit the fewest unsuitable terrain characteristics. High moisture content of the soil, which is generally associated with low-lying areas and wet-seasons conditions, is one of the most critical factors associated with unsuitable terrain characteristics. Training maneuvers might be scheduled during a dry season to avoid high moisture conditions.

Many of the mitigation procedures discussed in the other chapters of this report also qualify as procedures to reduce impacts on terrain. For example, a revegetation program (Chapters 6 and 9) will reduce erosion and gullying. These procedures, therefore, become mitigation techniques to reduce local effects of tactical vehicle training on terrain.

6 SOIL

Soil Considerations

There are two primary considerations when the suitability of soil for tactical vehicle training is evaluated: first, the ability of tactical vehicles to travel over the soil surface (trafficability); second, the effect of this movement on the soil.* Certain soils are more trafficable than others, and certain soils are more susceptible to erosion than others.

The soil evaluation procedure which follows includes both of these considerations and allows the user to establish soil suitability based on soil type. The procedure is general and has not been extensively field tested. However, results are considered fairly reliable for initial site selection. Detailed soil evaluation should be done before use of an area is allowed. This detailed evaluation should be performed by experienced soil engineers or scientists. The installation's FE office may have persons qualified to assist in the detailed evaluation. Other sources of assistance include the appropriate district office of the Corps of Engineers and State and local offices of the U.S. Department of Agriculture (USDA), Soil Conservation Service (SCS).

Evaluative Procedure

A simple way to determine and document soil suitability is to develop a soil limitations map. This technique has been used by land use planners to aid in the site selection of many land uses -- e.g. subdivisions and regional parks.[17] To develop a soil limitations map, the installation will first have to obtain a recent soil map of the proposed training site and any alternative areas.

It is important to note that Military Standard (MIL-STD) 619B, 12 June 1968, requires use of the Unified Soil Classification System (USCS) for Corps engineering projects.[18] This is necessary to provide a general concept of the engineering characteristics of foundation, embankment, and filter materials. In this report the emphasis on the suitability of soil is environmental. Consequently, the USDA Cooperative National Soil Survey Classification System is used. From an environmental point of view, properties that influence erodibility, trafficability, dustiness, and texture of the surface layer are important; these properties are reflected in the USDA classification system. Figures 5, 6, and 7 show the generalized relationship between the USCS, USDA, and other classification systems.

[17] L.J. Bartelli, et al., editors, Soil Surveys and Land Use Planning (Soil Science Society of America and American Society of Agronomy, 1966).

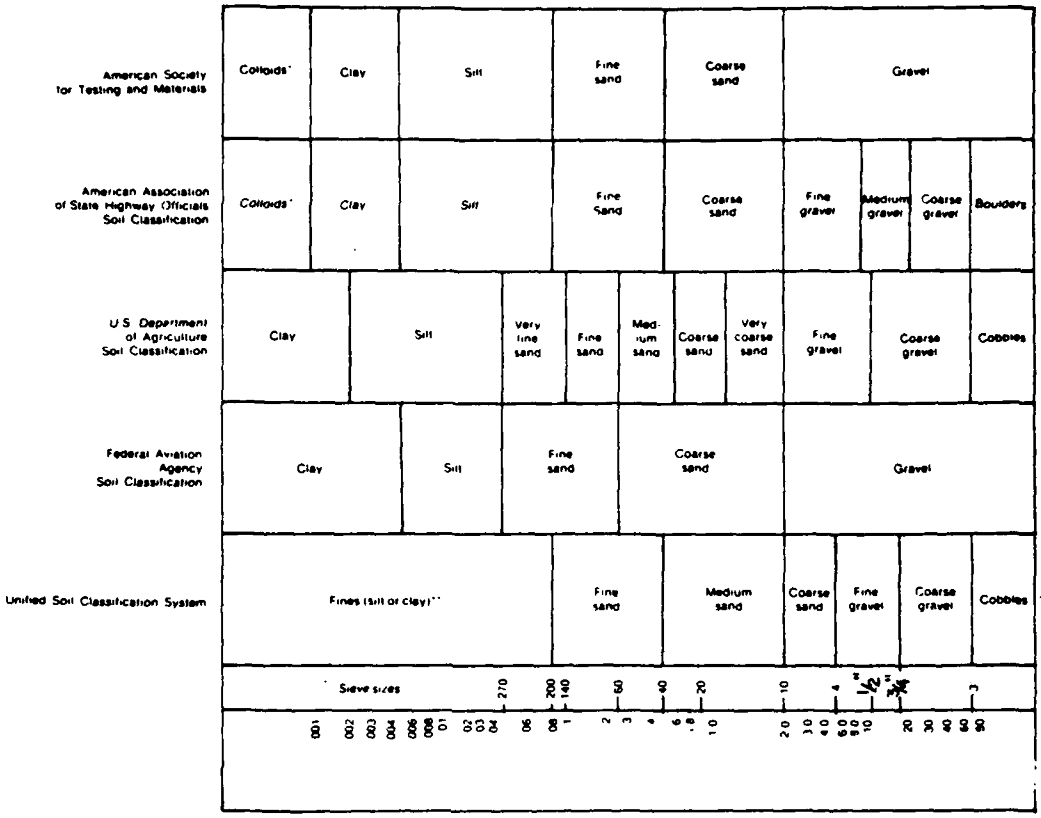
[18] Unified Soil Classification System for Roads, Airfields, Embankments, and Foundations, MIL-STD 619B (12 June 1968).

* For detailed information on the trafficability of soils and on methods to determine soil suitability in terms of trafficability, refer to WES reports in the series entitled Trafficability of Soils, Technical Memorandum No. 3-240, First through Twentieth Supplements (see Appendix C).

(This table may be used as a guide in classifying soils for which no engineering test data are available. The symbol > means "greater than," the symbol < means "less than.")

USDA texture class and symbol	Unified symbol	AASHO symbol	Soil properties related to classifications
Clay; silty clay	CH	A-7	High shrink-swell clays
"C", sic"	MH	A-7	Mica, iron oxide, kaolinitic clays
	CL	A-7	Low LL. Generally < 45 pct clay
Silty clay loam	CL	A-7	Low LL. Plastic (A-6 if clay < 30 pct)
"sicl"	ML-CL	A-7	Low LL. Mod. plastic (A-6 if clay < 30 pct)
	CH	A-7	High LL. High shrink-swell clays
	MH	A-7	High LL. Mica, iron oxide, kaolinitic
Clay loam	CL	A-6 or A-7	Low LL. Plastic
"cl"	ML-CL	A-6	Low LL. Moderately plastic
	CH	A-7	High LL. High shrink-swell clays
	MH	A-7	High LL. Mica, iron oxide, kaolinitic
Loam	ML-CL	A-4	Moderately plastic (A-6 if clay > 21 pct)
"l"	CL	A-6	Plastic (A-4 if clay < 22 pct)
	ML	A-4	Low plasticity (A-7 if clay > 21 pct)
Silt loam	ML—CL	A-4	Moderately plastic (A-6 if clay > 21 pct)
"sil"	ML	A-4	Low plasticity (A-7 if clay > 21 pct)
	CL	A-6	Plastic
Silt - "si"	ML	A-4	Low plasticity
Sandy clay	CL	A-7	Fines > 50 pct
"sc"	SC	A-7	Fines 50 pct or less
Sandy clay loam	SC	A-6	Plastic. Fines 36-50 pct
"scl"	SC	A-2-6	Plastic. Fines 35 pct or less
	CL	A-6	Plastic. Fines > 50 pct
Sandy loam	SM	A-2-4 or A-4	Low plasticity
"sl"	SC	A-2-4	Plastic
	SM-SC	A-2-4	Moderately plastic
Fine sandy loam	SM	A-4	Nonplastic. Fines 50 pct or less
"fsl"	ML	A-4	Nonplastic Fines > 50 pct
	ML-CL	A-4	Moderately plastic. Fines > 50 pct
	SM-SC	A-4	Moderately plastic. Fines 50 pct or less
Very fine sandy loam	ML-CL	A-4	Moderately plastic
"vfsl	ML	A-4	Low plasticity
Loamy sands	SM	A-2-4	Nonplastic. Fines 35 pct or less
"ls" "lfs"	SM-SC	A-2-4	Moderately plastic. Fines 35 pct or less
"lvfs"	SM	A-4	Low plasticity. Fines > 35 pct
	ML	A-4	Little or no plasticity
Sand, fine sand	SP-SM	A-3	Fines approx. 5-10 pct
"s", "fs"	SM	A-2-4	Fines approx. > 10 pct
	SP	A-3	Fines < 5 pct
Very fine sand	SM	A-4	Low plasticity
"vfs"	ML	A-4	Little or no plasticity
Coarse sand	SP GW	A-1	Fines < 5 pct
"cs"	SP-SM	A-1	Fines 5-12 pct
	SM	A-1	Fines 13-25 pct.
	SM	A-2-4	Fines > 25 pct.
Gravel, "G"	GP, GW	A-1	Fines < 5 pct.
50 pct passes No. 200	GM or GC	A-1	Fines 5-25 pct
50 pct of coarse	GM or GC	A-2	Fines 26-35 pct.
passes No. 4 sieve	GM	A-4	Fines > 35 pct.
	GC	A-6	Fines > 35 pct.

Figure 5. General relationship of systems used for classifying soil samples. (From Janet S. Wright, Theodore C. Vogel, Alexander R. Pearson, Jeffrey A. Messmore, Terrain Analysis Procedural Guide for Soil, ETL-0254 [U.S. Army Corps of Engineers, Engineer Topographic Laboratories, February 1981], p 35).



*Colloids included in clay fraction in test reports

**The L.L. and P.I. of silt plot below the A line on the plasticity chart and the L.L. and P.I. for Clay plot above the A line.

Modified from "PCA Soil Primer," Portland Cement Association, 1973

Figure 6. Comparison of particle size limits for selected soil classification systems. (From Janet S. Wright, Theodore C. Vogel, Alexander R. Pearson, and Jeffrey A. Messmore, Terrain Analysis Procedural Guide for Soil, ETL-0254 [U.S. Army Corps of Engineers, Engineer Topographic Laboratories, February 1981], p 37.)

In addition to the USDA system's suitability for addressing environmental concerns (wind and water erosion, etc.), the SCS has a large collection of existing information which is readily available for environmental planning (saving the acquisition costs of new data). This system is based on the USDA designations.

A survey of published USDA county and area soil surveys for 175 counties in which 150 active Army installations are located indicates that about 70 percent of the installations are at least partially covered by a soil survey. Nearly half of these surveys were done after 1950 and include soil maps. These surveys are readily applicable to the procedure, and may be obtained from the appropriate State or local SCS office.

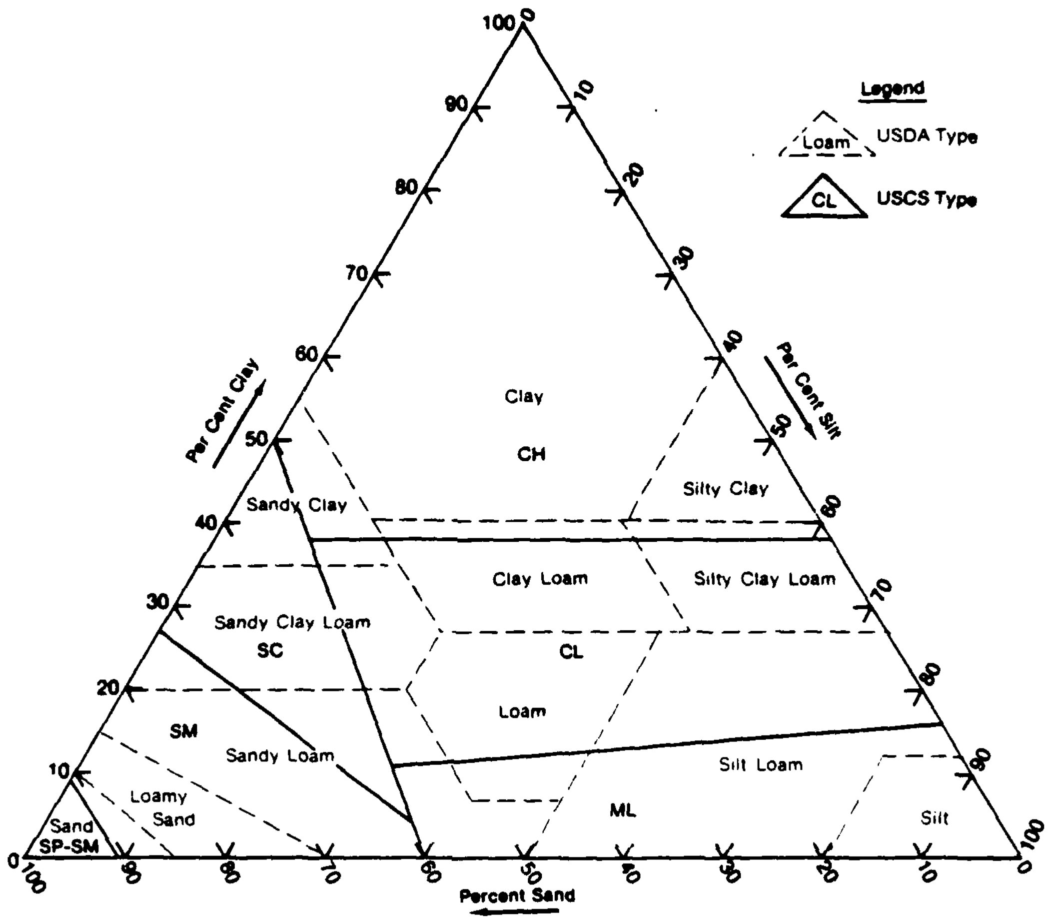


Figure 7. Guide for comparing USDA and USCS soil types. (From Janet S. Wright, Theodore C. Vogel, Alexander R. Pearson, and Jeffrey A. Messmore, Terrain Analysis Procedural Guide for Soil, ETL-0254 [U.S. Army Corps of Engineers, Engineer Topographic Laboratories, February 1981], p 38.)

Many installations have soil surveys or maps which were not done by the SCS but are still applicable to the procedure. Any survey which includes a map of soil boundaries and can be used to identify soils by USDA textural name is applicable.* If a survey is not available, assistance in preparing a reconnaissance soil map may be obtained from the local SCS. A memorandum of understanding established between the Department of Defense and the USDA allows cooperative agreements between installations and State and local SCS offices.[19] An experienced soil scientist can survey and map up to 250 to 500 acres (100 to 200 ha) per day. A short-term, 1- to 2-day effort can generally

* Surveys utilizing the United Soil Classification System (USCS) are generally applicable when used in conjunction with USDA surveys. Recent USDA surveys include a table which identifies selected soil series mapping units by the USCS and American Association of State Highway Officials (AASHO) classification systems.

[19] Natural Resources: Land, Forest, and Wildlife Management, AR 420-74 (DA, 1 July 1977), p 2-1.

be obtained at little or no cost; longer efforts can be obtained on a 50 percent shared-cost basis.

If SCS assistance is not available and the services of any other experienced soil scientist or consultant cannot be obtained, the user may be able to identify and map the soils at the proposed site. Simple mapping and identification procedures were developed as part of CERL's off-road recreational vehicle research and are described in Volume II of CERL Technical Report N-86.[20] While obtaining a cooperative agreement or using CERL's procedures may take some time, either approach will be useful in determining soil suitability if a soil survey or soil map is not available.

Once soil maps of the proposed training areas and alternatives have been obtained, the soils are rated as having slight, moderate, or severe limitations for use. These ratings are defined as follows:

1. Slight: soils that have textures that are acceptable for use. The probability is generally high that tactical vehicles of various types will be able to travel successfully over these soils; susceptibility to erosion is generally lower for soils of this type.

2. Moderate: soils that have textures that are moderately acceptable for tactical vehicle use. The probability is generally fair to excellent that tactical vehicles of various types will be able to travel over these soils, which are moderately susceptible to erosion.

3. Severe: soils with textures that are generally unacceptable for use. The probability is generally low that tactical vehicles will be able to travel over these soils, which can erode easily.

Table 6 identifies the ratings to be given to various soil textures. To determine the rating for a soil, simply compare its textural classification to the textures listed in Table 6. For example, assume that a soil map for a proposed area shows the boundaries of a soil named Tully silty clay loam. According to Table 6, soils with a silty clay loam texture have moderate limitations for tactical vehicle use. Therefore, the Tully silty clay loam has moderate limitations.

On some soil maps a particular map unit or named soil will not be accompanied by the name of the soil's texture. In most of these cases, the mapped soil will be a soil complex or association in which the soils have similar properties but the boundaries between them are not easily identified -- e.g., the Elmont-Clime complex in Kansas or the Susquehanna-Sumter-Houston association in Louisiana. Most soil surveys include detailed descriptions of each soil, soil complex, or soil association on the soil maps. These descriptions generally identify the predominant texture of the complex or association. Once texture is known, Table 6 can be applied. For example, the Elmont-Clime complex in Geary County, Kansas, is made up of 25 to 45 percent Elmont silt loam, 20 to 40 percent Clime silty clay loam, and about 20 percent soils that

[20] R. M. Lacey and H. E. Balbach, Evaluation of Areas for Off-Road Recreational Motorcycle Use, Volume II: Alternative Soil Suitability Determination Methods, Technical Report N-86 (CERL, December 1980).

Table 6

Soil Ratings for Tactical Vehicle Use[1]

Soil Texture and Texture Abbreviation[2]	Limitation Rating[3]
Sand (S)[4]	Slight
Loamy Sand (LS)[5]	Slight
Sandy Clay (SC)	Slight
Clay (C)	Slight
Sandy Clay Loam (SCL)	Moderate
Silty Clay (SIC)	Moderate
Sandy Loam (SL)	Moderate
Silty Clay Loam (SICL)[6]	Moderate
Clay Loam (CL)[7]	Severe
Loam (L)	Severe
Silt Loam (SIL)	Severe
Silt (SI)	Severe

Notes to Table 6

1 This table considers both the trafficability of soils (based on vehicles in a category which includes most all-wheel-drive trucks, a great number of trailed vehicles, and heavy tanks) and the susceptibility of soils to erode (based on erosion factor [K] approximations). The table was developed from a combination of sources, including Trafficability of Soils: Soil Classification, Technical Memorandum No. 3-240, Sixteenth Supplement (U.S. Army Engineer Waterways Experiment Station [WES], August 1961); K and T Factors of Soil Series Mapped in the Northeast Region (U.S. Department of Agriculture [USDA], Soil Conservation Service [SCS], June 1970); Guidelines for K Values (USDA, SCS, n.d.); W. H. Wischmeier, C. B. Johnson and B. V. Cross, "A Soil Erodibility Nomograph for Farmland and Contruction Sites," Journal of Soil and Water Conservation, Vol 26, No. 5 (September-October 1971); and an examination of the published values of K for 100 soils from various parts of the country.

2 Texture names and abbreviations are based on the USDA textural classification system.

Notes to Table 6 (Cont'd)

3 Soil ratings are defined as: (1) slight--given to soils that have textures that are acceptable for use; (2) moderate -- given to soils that have textures that are moderately acceptable for use; and (3) severe -- given to soils that have textures that are generally unacceptable for use.

4 As presented here, sands are not divided into coarse or fine sands. Coarse sands are generally less susceptible to erosion, and fine sands are generally more susceptible to erosion. Also, if the sands are in a low-lying area that has an extremely high moisture content, they should be rated moderate.

5 If loamy sands are in a low-lying area and have a high moisture content, they should be rated severe.

6 If silty clay loams are located on fairly steep slopes, they should be rated severe.

7 If clay loams are located in low-lying areas and have a high moisture content, they can be rated moderate.

Note: As a rule, soils on steep slopes generally have a lower possibility of being successfully traveled and are more susceptible to erosion.

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are similar to Elmont loam.[21] Since most of the soils in this complex would be silt loams, the complex has severe limitations for tactical vehicle use.

In most soil surveys, a few areas will be mapped but not identified as containing a singular soil, complex, or association. These may be areas (1) where the soils have been disturbed, e.g., landfills; (2) where the soil exhibits no particular properties which would give it a special classification, e.g., alluvial soils; (3) where a variety of intermingled soils exist such that it would be difficult to plot their boundaries on a map; or (4) where no soil has developed, e.g., granite outcrops. In these cases, the identification of a degree of limitation may be difficult. If necessary, a professional soil scientist may be consulted for a more accurate estimate of the degree of limitation these areas may have.

Once the limitation for each mapped soil unit on the proposed area's soil map is determined, the limitations map can be prepared. The first step is to reproduce the soil map for the area. This reproduction should illustrate the boundaries of each particular soil, soil complex, or soil association. The limitations map is prepared by coloring the soil mapping units, inside their respective boundaries, with an appropriate color indicating the degree of limitation. Soils with severe limitations are colored red (unacceptable), soils with moderate limitations are colored yellow (caution), and soils with slight

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[21] Soil Survey of Riley and Part of Geary County, Kansas (U.S. Department of Agriculture [USDA], Soil Conservation Service [SCS], June 1975), p 17.

limitations remain uncolored or can be colored green (acceptable). This creates a "stop light" map which is used for site selection and decision making.

Based on the soil limitations map, proposed training sites -- or portions of proposed sites -- can be considered acceptable or unacceptable. Areas left uncolored (or colored green) have slight limitations and are acceptable for tactical vehicle training. In other words, tactical vehicles will have little or no problem in traveling over these soils, and susceptibility to erosion is anticipated to be minimal. Areas colored yellow will have moderate limitations and may be considered acceptable with proper trail planning, training schedules, and erosion control procedures. Areas colored red have severe limitations and are unacceptable. However, these areas may also be used if mitigation procedures are implemented.

Since many of the soils on most installations will have moderate or severe limitations, it may be necessary to include such soils in the use area. If this must be done, special considerations related to soil suitability should be applied. Many of these considerations are identified in the following mitigation procedures.

Mitigation Procedures

The impact of tactical vehicle training on soils can be reduced best if installations use areas which have the most acreage with slight and moderate limitations. Such areas can be selected by examining the soil limitations map and comparing alternative sites.

In the development of Table 6, every attempt was made to provide a general rating scale which could be used in most situations without regard to site or training activity specifics. However, several possible rating variations apply if specifics are known. Some variations are provided as footnotes to the table. These and other variations are described below and may be used to further the selection of the best site for tactical vehicle training.

1. Degree of Limitation. The textures on Table 6 were ordered, as much as possible, according to severity of limitation, and then evenly divided into slight, moderate, and severe categories. For example, both silty clay and silty clay loam are listed as having moderate limitations; however, silty clay is considered to have less limitation in terms of trafficability and erodibility. Therefore, it was placed before silty clay loam. In site selection, the order of the listed textures on Table 6 (i.e., best suited to least suited) should be considered. That is, if all alternative areas considered have only soils with moderate limitations (as identified in Table 6) an area with more sandy clay loam soil is more acceptable than an area with more silty clay loam soil (Table 6). The procedure used to map limitations can be modified to reflect this; i.e., areas with SCL soils can be colored green and areas with SICL soils can be colored red.

2. Vehicles. Trafficability studies used to develop the soil classification scheme for Table 6 consider seven categories of vehicles. These categories are listed on Table A1 in Appendix A. Table A2 lists examples of the type of vehicles in each category. Vehicles are placed in categories one

through seven, depending on their ability to traverse various soils, with category one being the least susceptible to being stranded and category seven being the most susceptible. Table 6 was developed based on the trafficability of vehicles in category 5, most all-wheel-drive trucks, a great number of trailed vehicles, and heavy tanks. But if the vehicles expected to participate in proposed maneuvers are generally in a lower category, their probability of being stranded will not be as high and the limitations for soils over which these vehicles will travel may not be as severe as Table 6 indicates. In other words, a soil rated severe for vehicles in category 5 may only have moderate limitations to vehicles in category 3.

3. Slope. The degree of slope on which a soil is located directly affects its susceptibility to erosion. The greater the degree of slope, the greater the amount of erosion likely to occur. Therefore, if two alternative sites exhibit soils or limitations which are very close, the site with the least relief -- i.e., smallest average degree of slope or change in elevation -- is the most suitable.

4. Stoniness. Soils which contain many coarse stones, regardless of texture, tend to be more trafficable and less susceptible to erosion. Therefore, very gravelly or stony soils have slightly lower limitations, and areas which are very stony are more suitable for tactical vehicle use.

5. Wetness. Soils which are wet or exhibit an unusually high moisture content are less trafficable and generally more susceptible to erosion. Therefore, alternative sites with relatively drier soils are more suitable for tactical vehicle use.

Regardless of the area chosen, tactical vehicle use will damage soils and increase the potential for erosion. Many, if not all, erosion control techniques therefore can be listed as methods to lessen the impacts of tactical vehicle training on soils. These techniques include revegetation, application of dust palliatives, application of mulch, drainage controls, check dams, sedimentation basins, and many more. Table 7 provides a list of many applicable Army publications which will provide ideas and guidance on procedures which can be used for erosion control and soil management. (Also see Appendix C.)

Control and scheduling of vehicle movement are two final techniques applicable to limiting soil damage and erosion. When appropriate, tactical vehicle movement should be confined to trails. If an extensive program of trail maintenance is necessary to ensure this, it is strongly recommended. Scheduling maneuvers to avoid very dry and very wet seasonal conditions is also recommended.

Table 7

Army Technical Manuals Related to Erosion Control and Soil Management

TM No.	Title	Date
5-630	Repairs and Utilities: Ground Maintenance and Land Management	4 Dec 67
5-631	Installation--General: Woodland Management	7 Apr 63
5-820-4	Drainage and Erosion Control Drainage for Areas Other Than Airfields	15 Jul 65
5-822-4	Soil Stabilization for Roads and Streets	13 Jun 69
5-830-3	Dust Control	30 Sep 74
5-830-4	Planting and Establishment of Trees, Shrubs, Ground Covers and Vines	15 Jun 76
5-866-6	Soils, Drainage and Planting for Emergency Construction: Establishing Turf, Emergency Construction	1 Jul 65
5-886-7	Soils, Drainage and Planting for Emergency Construction: Dust Control, Emergency Construction	30 Jun 64
5-887-5	Soil Stabilization: Emergency Construction	25 May 66

7 AIR QUALITY

Air Quality Considerations

Exhaust emissions associated with tactical vehicle maneuvers are generally considered an insignificant environmental problem -- primarily because most maneuver areas are isolated. Therefore, exhaust emissions are not treated as a primary consideration in this report. More research into the impact of tactical vehicle exhaust emissions on ambient air quality is required before any definitive statements can be made about the problem.

Dust, is a result of wind erosion, is the principal air-quality problem associated with tactical vehicle training. Wind erosion is the result of three forms of soil movement: saltation, surface creep, and suspension.[22] Saltation is a bouncing motion of soil particles close to the ground. Surface creep is a slow movement of soil particles along the ground. This is caused by the impact of saltating soil particles bouncing against heavier soil particles that cannot be dislodged into the air. Suspension is the transport of much smaller and lighter soil particles by the wind.

Site factors which induce and aggravate wind erosion are dry climate, bare soil, lack of windbreaks, heavy traffic, and faulty conservation practices.[23] Other variable factors which contribute to wind erosion and dust problems are soil particle size and the speed of vehicles. Smaller soil particles have a greater tendency to become airborne. As vehicle speed increases over bare soils, the number of soil particles which tend to become airborne increases.[24]

The major dust problems associated with tactical vehicle training occur during, and as a result of, two activities: (1) convoy movement to and from the training site, and (2) vehicle movement at firing ranges, particularly along moving fire courses. Problems associated with convoy movement are visibility and dust fallout on sensitive land uses. Decreased visibility is a safety hazard and dust fallout can create considerable controversy. Dust fallout also increases the maintenance costs of structures when cleaning activities are required. Visibility is a significant problem at firing ranges.

Evaluative Procedure

As with terrain evaluation (Chapter 5), the following procedure is not systematic and does not provide quantitative results, but presents various suitable and unsuitable characteristics which should be considered when

[22] William Canessa, "Dust Retardants," in Paul N. Cheremisinoff and Richard A. Young, editors, Air Pollution Control and Design Handbook, Part 1 (Marcel Dekker, Inc., 1977), p 431.

[23] Canessa, p 431.

[24] Investigation of Fugitive Dust -- Sources, Emissions and Control, U.S. Environmental Protection Agency (USEPA) Report No. APTD-1582 (PEDCo -- Environmental Specialists, Inc., May 1973), p 3-5.

selecting sites for access trails, firing points, and moving fire courses. These characteristics are not entirely applicable for choosing areas for cross-country movement. However, the evaluation procedures and selection criteria provided in other chapters will aid in selecting suitable cross-country areas.

Information sources for evaluating sites include topographic maps, soil surveys, soil maps, vegetation surveys and land use plans. Once all information sources have been reviewed, the characteristics of each alternative site are compared with the suitable and unsuitable site characteristics. If a proposed trail or firing point exhibits several suitable characteristics, it may be considered more acceptable for use. Any unsuitable characteristics should be noted as areas for environmental concern. If alternatives are being evaluated, the site which exhibits the greatest number of suitable characteristics should receive primary consideration.

For this particular environmental element, major considerations for site selection are methods that will be used to control dust. For example, vehicle movement over trails will undoubtedly produce dust. Therefore, soil type and particle size will be of concern in trail selection. However, if trails are to be paved, or if dust palliatives are to be applied regularly, these soil considerations become much less critical.

The following paragraphs describe suitable and unsuitable site characteristics related to air quality. These characteristics are summarized in Figure 8.

Unsuitable Site Characteristics

Soils. Airborne dust and saltating soil particles are the most significant forms of wind erosion and air quality problems related to vehicle trails and firing points. Therefore, the most unsuitable soils are those with smaller particle sizes. Sands are the largest soil particles, and silts are the next largest. Since clayey soils have the smallest particles, they are the most susceptible to wind erosion and, in terms of air quality, the most unsuitable for trails and firing point locations. (Note, however, that in winds with very high velocities, silts and sands may also be unsuitable.)

To determine the soil suitability of various sites for trails or for firing points, procedures similar to those described in Chapter 6 can be used. This will require soil maps which identify soil textures by the USDA soil classification system. For this procedure, unsuitable soil textures are those with the greatest small particle (clay and/or silt) content. More suitable soil textures are those with the greatest large particle (sand) content. Table 8 provides a list of soil textures by particle size.

Table 8 is used like Table 6. Note, however, that the rank order of the textures listed in Tables 6 and 8 is slightly different. Table 6 considers both trafficability and overall susceptibility to erosion while Table 8 considers only soil particle size. Therefore, the user should consider both Tables 6 and 8 in his evaluation. If a site being examined is in a particularly arid climate where dust is a common problem, the user should give more consideration to the results obtained using Table 8. If the site is in a humid climate where dust is not a common problem, he may prefer to use Table 6

GENERAL AIR QUALITY CONSIDERATIONS

When Site Characteristics Are Evaluated for Possible Tactical Vehicle Use, Areas May Be Considered Generally

UNSUITABLE IF:	SUITABLE IF:
1. More than 50 percent of the area has soils that are clays, silts, silty clay loams, and silty clays.	1. More than 50 percent of the area has soils that are sands, loamy sands, sandy loams, and sandy clay loams.
2. More than 75 percent of the area has soils that are sandy clays, loams, clay loams, silt loams, clays, silts, silty clay loams, and silty clays.	2. More than 75 percent of the area has soils that are sands, loamy sands, sandy loams, sandy clay loams, sandy clays, loams, clay loams, and silt loams.
3. Any dust-sensitive land use is located within 3280 ft (1000 m) of the area or route to the area.	3. All dust-sensitive land uses are located at distances greater than 3280 ft (1000 m) away from the area.
4. There are no natural windbreaks in the area; e.g., hills and trees.	4. There are natural windbreaks in the area.

Figure 8. Suitable and unsuitable site characteristics related to air quality.

exclusively since it relates more to trafficability and erosion from both wind and water.

With both tables, the suitability of each soil along an access trail or at a firing point is determined by preparing a limitations map. For example, suppose that a proposed location for a moving fire course has been identified, and according to the soil maps of the area, the soil textures along the course are silts and silt loams. According to Table 8, silts and silt loams can have relatively high clay and silt contents. Therefore, use of the site may result in considerable dust, depending on the amount of exposed soil and on wind conditions. According to Table 6, silts and silt loams would also have severe limitations because of trafficability and susceptibility to both wind and water erosion. Therefore, the site is relatively unsuitable.

The limitations map is prepared as described in Chapter 6. If suitability is based entirely on wind erosion and dust factors, the user should assign relative degrees of limitations (i.e., slight, moderate, and severe) to each soil texture on Table 8. These should be based on the type of soil textures

Table 8

Soil Particle Contents for Wind Erosion Evaluation*

	Estimated Percentages of Clays, Silts, and Sand That Are Likely for Various Soil Textures		
Soil Texture	Clay	Silt	Sand
Sand (S)	0 - 15	0 - 15	85 - 100
Loamy Sand (LS)	10 - 30	0 - 30	70 - 90
Sandy Loam (SL)	15 - 57	0 - 50	43 - 85
Sandy Clay Loam (SCL)	20 - 55	0 - 28	45 - 80
Sandy Clay (SC)	35 - 55	0 - 20	45 - 65
Loam (L)	48 - 77	28 - 50	23 - 52
Clay Loam (CL)	55 - 80	15 - 53	20 - 45
Silt Loam (SIL)	50 - 100	50 - 88	0 - 50
Clay (C)	55 - 100	0 - 40	0 - 45
Silt (SI)	80 - 100	80 - 100	0 - 20
Silty Clay Loam (SICL)	80 - 100	40 - 73	0 - 20
Silty Clay (SIC)	80 - 100	40 - 60	0 - 20

* Based on the USDA textural triangle.
Note: The order of textures listed here is from those likely to have the least clay content and greatest sand content to those likely to have the most clay content and least sand content. The order is based on the medians of the ranges of clay and sand content. Since ranges are represented, the order may not reflect the real particle contents at actual sites.

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at surrounding and alternative locations. For example, if no soils in or around alternative sites are clays, silts, silty clay loams, or silty clays, the most unsuitable soils are those with the next highest clay and lowest sand content -- e.g., clay loams, or silt loams.

Land Use. Certain land uses and activities are sensitive to dust. The location and type of land uses next to proposed access trails or maneuver areas may make the sites unsuitable because of dust. In general, land uses sensitive to dust are those involving human activity for at least 8 hours per day -- e.g., housing, offices, etc. As a rule, any such land use within 3280 ft (1000 m) of a proposed training area or trail will make the area or trail unsuitable unless some form of dust control is used -- e.g., paving or palliatives (see Mitigation Procedures, p 52).

Windbreaks. Windbreaks can be valuable in reducing the amount of dust generated by tactical vehicle movement. Various surface features can act as windbreaks, including man-made structures, natural hills, and tall vegetation. These features decrease wind velocities -- and reduce the potential for wind erosion -- if the direction of wind is perpendicular to the length of the surface feature. (Note, however, that wind velocities can be increased if the direction of the wind is parallel to the length of surface obstructions.)

Since there may be no windbreak, sites on hilltops may be unsuitable. Sites in relatively open terrain (e.g., on flat plains and surrounded by low vegetation) may also be considered unsuitable.

Seasonal Characteristics. Soil moisture content is another consideration which may make one site less suitable than others. The presence of moisture in exposed soil tends to keep soil particles from becoming airborne. Therefore, proposed locations where the soils are relatively drier than other adjacent or surrounding locations may be considered unsuitable. When evaluating site characteristics, the user should consider seasonal changes in the soil moisture content. Sites or trails may be unsuitable during the dry season of the year but more suitable during the wet season.

Suitable Site Characteristics

Soils. Soils with the greatest number of large soil particles -- i.e., sand -- provide the fewest problems with dust. The considerations and procedure described earlier can be used to determine sites with suitable soils.

Land Use. Any dust-sensitive land use next to a proposed tactical vehicle trail or moving fire course would tend to make the site unsuitable for use when dust is a major consideration in site selection. Proposed sites located 3280 ft (1000 m) from any dust-sensitive land use can generally be considered suitable. If dust control measures are planned, proposed sites within 3280 ft (1000 m) of dust-sensitive land use may also be considered.

Windbreaks. Proposed sites with either natural or manmade windbreaks are more suitable for use than other sites. Hills and tall vegetation (e.g., timber stands) can act as windbreaks. Man-made structures, such as berms, will also serve as windbreaks. Special consideration should be given to choosing sites with the maximum amount of windbreak if dust (air quality) problems are to be minimized.

Mitigation Procedures

Techniques for minimizing air quality problems associated with dust can be divided into four general categories: physical stabilization, vegetation stabilization, structural modification, and operational modification. Each category and certain control techniques are briefly described below. Many of the techniques are also described in the Technical Manuals listed in Table 7. Others are described and further discussed in various sources found in the Bibliography (Appendix C). USDA, SCS soil scientists can provide considerable information on wind erosion and mitigation techniques.

Selection of the proper technique for each situation is dependent on a number of variables. Preliminary recommendations for appropriate mitigation can be developed using good judgment. Techniques which are actually implemented should be selected after detailed examination of the costs and benefits of the options available. Generally, a combination of procedures will provide the greatest benefit at the lowest cost.

Physical Stabilization

Physical stabilization involves covering the exposed soil surface with a material that prevents the wind from disturbing the surface particles -- i.e., dust palliatives or dust retardants, which include water, fresh oil, and a variety of commercially manufactured chemicals. Water is not a very useful long-term retardant. It is effective as long as the surface is wet, but once dry, dust problems return and in some cases are more severe than before. Fresh oil can be effective, but only about 10 percent stays on the road surface, most is carried away by vehicles or runs off into streams. Certain commercially manufactured chemicals have proven fairly effective if applied properly. TM 5-830-3 and TM 5-886-7 provide considerable information and guidance in the choice of dust palliatives (Table 7).*

Vegetation Stabilization

Vegetation stabilization involves establishing a suitable native vegetative ground cover, and is very effective in reducing soil loss. However, as a control measure it should be restricted to areas where the vegetation will receive limited mechanical disturbance after being established.[25] In certain instances, vegetation can act as both a dust retardant and windbreak. It is recommended that this form of control be used whenever possible. Native vegetation is generally the best source of cover since it is adapted to climate and soil conditions. Fertilizers should be applied if necessary. Vehicle movements should be controlled to avoid disturbing regrowth and increasing the amount of exposed soil.

Structural Modifications

Structural modification refers to changing natural physical features. Construction of earthen berms to create windbreaks is a form of structural modification. For trails, paving is the most effective structural modification technique (and perhaps the most effective dust control technique). Paving is costly, but can be done along trail segments where dust problems may be considerable -- e.g., trail segments very close to dust-sensitive land uses. If proper drainage control techniques are used, paving also reduces the amount of water erosion associated with trail development.

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* Two other references are also excellent sources for information on the effectiveness and cost-benefit of various dust control measures: Investigation of Fugitive Dust -- Sources, Emissions and Control, USEPA Report No. APTD-1582 (PEDCo -- Environmental Specialists, Inc., May 1973); and B. H. Carpenter and G. E. Weant, III, Particulate Control for Fugitive Dust, USEPA Report No. EPA-600/7-78-071 (Research Triangle Institute, April 1978).

[25] B. H. Carpenter and G. E. Weant, III, Particulate Control for Fugitive Dust, USEPA Report No. EPA-600/7-78-071 (Research Triangle Institute, April 1978), p 41.

Operational Modifications

Scheduling and control of vehicle movement are operational modifications. Training maneuvers can be scheduled to avoid the dry season, when soils are more susceptible to wind erosion. The use of trails and firing points can be alternated to avoid using the most unsuitable routes or sites during the dry season. If enough area is available, there may be several trails or firing points established so that use can be scheduled on a rotating basis to allow sites to recover. Generally a recovery period should last at least 1 year. However, the specific length of time depends upon climatic conditions and the degree of disturbance.

Other operational modifications include controlling vehicle speed and movement. Since increases in vehicle speed increase the amount of dust, speed limits might be established along critical segments of access trails. However, this can be truly effective only if speed limits are enforced. Controlling movement or limiting use to designated, carefully selected sites and trails will limit the amount of disturbed vegetation and exposed soil.

8 WATER QUALITY

Water Quality Considerations

Sediment in streams is the most significant impact on water quality associated with tactical vehicle maneuvers. Sediment enters streams through erosion of exposed soil at intensive use areas and along trails, and during stream crossing. Petroleum, oils, and lubricants (POLs) which enter streams as a result of training activities should be negligible; no real data exist on the quantity of the POLs which might enter streams. Potential sources of POLs are improper disposal of waste oil and the washing action on vehicle surfaces during stream crossing.

Many installations where tactical vehicle maneuvers are conducted have fast-moving streams. As a result, most sediments and any POLs entering streams are soon flushed downstream and off the installation. Depending on the volume of sediments and POLs, this can have a significant impact on downstream activities and land uses.

Most of the site selection considerations discussed in previous and following chapters can also be applied to minimize the amount of sediment affecting water quality. Terrain (Chapter 5) and soil (Chapter 6) considerations are directly applicable. All soils can be eroded by water; however, some soils are more susceptible to erosion than others. The evaluative procedure for soils considers erodibility (pp 38-45). The rate and amount of erosion which can occur is directly related to the degree and length of slopes, and to the type and stability of ground cover. More soil material will erode faster on steeper, longer slopes, especially if there is no dense ground cover. Terrain characteristics identified as suitable and unsuitable include this as a consideration.

There are few site selection considerations to minimize the amount of POLs that are washed off of vehicles. Stream crossings with deep, rushing water should be avoided. Wet and dry season crossings should be considered; i.e., crossings with normally high water might be used in the dry season but avoided during wet season, during high-water conditions, and after any heavy rainfall. Proper disposal of waste POLs is an action which does not relate to site selection but should be emphasized for training activities.

Evaluative Procedure

Since the soil and terrain evaluation procedures consider erosion and soil loss, they can be considered primary evaluation techniques for selecting sites which will minimize sediment loads and their effect on water quality. More detailed and/or technical procedures are not provided here. However, additional suitable and unsuitable site characteristics are described below and briefly summarized in Figure 9.

Most of the site characteristics relate to sites for stream crossings. Information sources for identifying these characteristics include topographic maps, geologic maps, soil maps and any source of stream flow characteristics or water quality data. Environmental and natural resource sections of the

GENERAL WATER QUALITY CONSIDERATIONS

When Site Characteristics Are Evaluated for Possible Tactical Vehicle Use, Areas May Be Considered Generally

UNSUITABLE IF:	SUITABLE IF:
1. Slopes are normally long and steep.	1. Slopes are not normally long and steep.
2. Slopes near stream crossing sites normally exceed 5 to 10 percent.	2. Slopes near stream crossing sites do not normally exceed 5 to 10 percent.
3. More than 40 percent of the soils located within 3280 ft (1000 m) of streams or ponds have severe limitations.	3. More than 60 percent of the soils located within 3280 ft (1000 m) of streams or ponds have slight or moderate limitations.
4. There is considerable surface water in the area, especially ponds, lakes, and streams that flow year-round.	4. There are few streams and ponds in the area, especially if streams are intermittant.
5. The water or ecological value of streams or ponds located on or near the site is high.	5. The water or ecological value of the streams or ponds located on or near the site is of low or marginal value.
6. Streams are deep and fast flowing and/or have high, steep banks.	6. Potential sites for stream crossing have bedrock bottoms.
7. There is already exposed or damaged soil near water bodies.	7. There is stable vegetation along streams.

Figure 9. Suitable and unsuitable site characteristics related to water quality.

installation FE office are excellent sources of this type of information. Federal and State geologic and water survey agencies are other excellent sources.

Unsuitable Site Characteristics

Topography. Since soil loss is a function of slope characteristics, topography is a major consideration in selecting sites. Areas with normally steep and long slopes would be unsuitable. This is especially true of areas requiring stream crossings or being chosen specifically to provide stream-crossing training. If possible, areas where crossings may be required should be chosen so that nearby slopes do not normally exceed 5 to 10 percent or less.

Soils. Use of the soil evaluation procedure described in Chapter 6 will help identify areas with unsuitable soils -- i.e., those that are very susceptible to erosion. These are generally clays and silts. Clayey or silty soils are especially unsuitable if located along streams where crossing may be required.

Surface Water. Proposed sites with much surface water (i.e., significant numbers of streams or ponds) are unsuitable -- even if stream-crossing training is required. Stream-crossing training should be conducted in specially selected areas which are used intensively and where mitigation procedures can be performed easily. Proposed sites with ponds or lakes are generally unsuitable since sediments which enter them are not flushed out; the lakes or ponds may soon be filled with soil. In some cases, the existing quality of water or the ecological value of streams and ponds on or next to a proposed training area may be considered very good. Training activities near these water bodies would be unsuitable unless appropriate mitigation techniques were used.

Stream Characteristics. Streams with high, steep banks are generally less suitable as sites for stream crossing. Crossings along these streams usually require grading. This increases slope length and exposes more soil material. Deep, fast-flowing streams are particularly unsuitable for crossing since they will only increase erosion at crossing access points and wash more sediments and POLs from vehicle surfaces.

Seasonal Characteristics. Since deep, fast-flowing streams are generally more unsuitable for stream crossing, certain seasonal conditions or types of streams may be considered unsuitable. Proposed training areas where the streams contain water during the entire year are less suitable than those where streams are intermittent -- i.e., contain water only during certain times of the year. The impacts to water quality -- as with many other environmental elements discussed in this report -- are decreased if wet season conditions are avoided. That is, stream crossing should be avoided during the wet season and at other times when there is high water flow.

Suitable Site Characteristics

Topography. Proposed training areas with average slopes that are not normally long and steep are generally more suitable. Areas where the slopes adjacent to any streams or ponds are generally less than 5 to 10 percent are also considered more suitable.

Soils. Soils acceptable for tactical vehicle training can be identified using the soil evaluation procedure described in Chapter 6. Sands or sandy soils are generally more suitable, especially at stream crossing locations. Gravelly or stony soils are also generally more suitable.

Surface Water. Proposed training areas with a minimal amount of surface water are usually more suitable since exposed soil material has less opportunity to enter streams. Areas where the existing water quality or ecological value of streams or ponds is poor may or may not be more suitable, depending on the amount of sediment expected to enter streams. If much sediment is expected, impacts to any stream, whether of little or great value, are unacceptable. If the sediment expected to enter streams is minimal, areas where streams are already of marginal quality would be more suitable. Every attempt should be made to carry out mitigation procedures so that streams or ponds of marginal value receive little impact.

Stream Characteristics. Proposed training areas where streams are intermittent are generally more suitable than areas where stream flow occurs year-round. Areas where streams or ponds are bordered by dense vegetation are also more suitable. This vegetation reduces the amount of soil material which will actually reach the water, thereby reducing sediment loads. Streams with bedrock bottoms are especially suitable for stream crossing activities.

When proposed training areas are evaluated, all suitable and unsuitable site characteristics should be considered. The unsuitable characteristics of any proposed area should be noted. This information and any appropriate mitigation procedures should be forwarded to the decision-maker. If alternative areas are being considered for use, the area which exhibits the fewest unsuitable site characteristics should be preferred.

Mitigation Procedures

Since sediment load in water is directly related to soil erosion, the general erosion control and soil management techniques mentioned in other chapters (especially Chapter 6) are the primary techniques for controlling impacts on water quality. Other specific procedures are proper site selection, scheduling, and soil stabilization for critical locations.

Sites should be chosen so that a minimal amount of surface water is affected by sediment. Unless water-crossing training is required, vehicles should be kept a good distance from any surface water. If water-crossing training is the mission, specific crossing sites should be selected. Crossing should be confined to specific areas and sediment control procedures or structures should be provided -- sediment basins, for example.

Training activities should be scheduled when the potential for water erosion is minimal. Therefore, wet season conditions should be avoided. Training should also be avoided after heavy rainfall.

Proper POL-waste disposal will reduce the amount of POLs entering streams. Deliberate washing of vehicles in streams should be avoided. The effects of these actions can be emphasized during pretraining briefings.

Soil stabilization at critical sites along streams can do much to reduce the sediments which enter streams. Erosion control and soil stabilization at stream crossing points is extremely useful.

Reducing the speed of runoff water before it enters streams is also useful. This can be done by terracing slopes near streams and establishing vegetation barriers between training sites and streams. When the speed of runoff water is reduced, heavier soil particles are deposited before they reach the stream. Special consideration should be given to locations along streams where erosion is already a problem -- e.g., gullies and exposed soil along stream banks. Every attempt should be made to stabilize the soil and reduce the speed of runoff water at these places.

9 VEGETATION

Vegetation Considerations

Plant life is extremely diverse in the United States and other areas of the world where tactical vehicle training is conducted. As a result, the activities involved in tactical vehicle training can have extremely diverse effects on vegetation. For example, a pine tree, 4 in. (101.6 mm) in diameter, that is damaged or killed at Fort Carson, CO -- an arid, slow growing area -- may be 200 years old; a pine tree of the same size at Fort Polk, LA -- a humid, fast-growing area -- may be 3 to 4 years old. Similarly, a rut caused by a vehicle at Fort Riley, KS, will soon be filled with non-native weedy, broad-leaved species instead of native grasses. In contrast, the native grasses on the moraine prairies at Fort Lewis, WA, will regrow in the ruts, but other, more sensitive species, such as native mosses and violets, will be lost. The extent of damage to vegetation caused by training is related to plant resiliency, growth rates, reproductive rates, and soil topography and climate.

Vegetation has several qualities that make its existence critical. First, the most efficient and economical way to reduce soil erosion is to maintain a good, stable vegetation cover. Second, plants play an important role on ranges and during cross-county maneuvers where training requires realism. Finally, plants are the base of the food chain, and animal life depends on plant production for cover.

Because of its importance, the vegetation in a proposed training area must be examined. This examination should, at a minimum, determine the relative value of the vegetation resources in the proposed training site. If possible, it should also consider the possible impact of tactical vehicle training.

Research designed both to quantify the effects of tactical vehicles on vegetation and to describe the mechanism of such effects is in its infancy.[26] The operation of tactical vehicles will directly destroy plants because of mechanical injury, and will cause soil compaction which will restrict plant growth. However, it is not possible at this time to predict exactly how much damage will be caused by training activity. Therefore, an examination of the suitability of an area's vegetation will rely on structured judgment.

When a new training area is to be located in areas that are primarily shrubland, grassland, or desert, one particular consideration is obvious. Most, if not all, damage to such areas will be done by the vehicles themselves, and the major problem will be wind, or water-aided soil erosion. In some areas, particularly in arid regions, wind-aided erosion can be a significant difficulty.

Much of the damage associated with tactical vehicle training is done to forest vegetation during the initial stages of clearing land for training

[26] W. D. Severinghaus, R. E. Riggins, and W. D. Goran, Effects of Tracked Vehicle Activity on Terrestrial Mammals, Birds and Vegetation at Fort Knox, KY, Special Report N-77/ADA073782 (CERL, July 1979).

purposes. This clearing is needed for sighting visibility or for alteration of the natural environment to simulate combat conditions. Clearing is generally done in one of two ways: timber harvest or general clearing. The impacts of any clearing should be carefully considered when proposed training areas are evaluated.

Evaluative Procedure

The following procedure will help in examining vegetation resources. The procedure is systematic and is designed to be used even if quantitative data are not available. It is best suited for comparison of alternative sites.

The procedure should be completed by someone with at least some education and experience in the biological sciences. Assistance may be obtained from experienced personnel in the natural resources section of the FE Office. However, it is strongly recommended that the procedure be completed by a professional biologist with field qualifications -- and then only after a site visit and at least a visual survey of the alternative areas. This may involve more time but it will ensure the reliability of the results.

With the procedure, alternative areas are evaluated in either of two ways: (1) the "relative value" of the vegetation in the areas is determined, or (2) the "susceptibility to damage" of the vegetation is determined. The latter method is actually an extension of the first and is completed if the examiner is familiar with the types of damage that will result from tactical vehicle use or from clearing operations.

The following instructions for each approach are accompanied by an example for a hypothetical area. The example for the "relative value" approach is illustrated in Figure 10. The example for the "susceptibility to damage" approach is illustrated in Figure 11. Blank copies of the forms used in Figures 10 and 11 are provided in Appendix B. The circled numbers on Figures 10 and 11 refer to the corresponding steps in the following text. They are provided to illustrate the portion of the evaluation form which relates to each step.

The "Relative Value" Approach

Step 1, Area. Assign a special designation to each alternative area. The designation -- e.g., Area 1 -- is used to distinguish one area from another. If a site represents two or more distinct vegetative communities, the areas covered by the different communities should be considered separately.

Step 2, Vegetation Resources. Several categories of vegetation resources are listed in this column -- e.g., "Dominant Ground Cover," "Dominant Shrub Strata." Under each category, list the specific vegetation resources known to exist either in the area being examined or on the installation -- e.g., "Rock Cedar" and "Live Oak." Identify any other significant species or vegetation factor which is not easily categorized by listing it under the category "Other." The list of vegetation resources can be compiled from existing data, but remember that a site visit is strongly recommended. The last column in

(1) Area AREA 1

(6) Rating 3.7 Rank 5 (8)

VEGETATION Limitation RARE/ENDANGERED SPECIES, PARTICULARLY THE PRESENCE OF "BIG TOOTH MAPLE" (7)

(2) Vegetation Resources	(3) Relative Value	(4) Categorical Value	Susceptibility to Damage	Categorical Susceptibility	Combined Resource Value	Notes
DOMINANT GROUND COVER		3				
TEXAS GRAMA	3					
RED GRAMA	2					
BEDSTRAW	2					
DOMINANT SHRUB STRATA		4				
FRAGRANT SUMAC	4					
POSSUM-HAW	3					
DOMINANT TREE STRATA		4				
ROCK CEDAR	3					
LIVE OAK	1					
POST OAK	4					
TEXAS OAK	2					
CEDAR OAK	2					
RARE / ENDANGERED SPECIES		5				
BIG-TOOTH MAPLE	5					
PINCUSHION CACTUS	3					
MOUND CORY	1					
PEST SPECIES		3				
POISON IVY	3					
ECONOMIC VALUE		3				
ROCK CEDAR	3					
LIVE OAK	1					
Other		—				
	—					

(5) Total Area Value { 22 } Total Combined Resource Value { }

Figure 10. The "relative value" approach to evaluating vegetation for tactical vehicle use.

Area ARFA I

(5) Rating 12.1 Rank 3 (7)

VEGETATION Limitation RARE / ENDANGERED SPECIES, PARTICULARLY THE PRESENCE OF "BIG TOOTH MAPLE" (6)

(1) Resources	Relative Value	Categorical Value	(2) Susceptibility to Damage	(3) Categorical Susceptibility	(4) Combined Resource Value	Notes
DOMINANT GROUND COVER		3		2	6	
TEXAS GRAMA	3		2			
RED GRAMA	2		2			
BEDSTRAW	2		4			
DOMINANT SHRUB STRATA		4		3	12	
FRAGRANT SUMAC	4		3			
POSSUM-HAW	3		2			
DOMINANT TREE STRATA		4		3	12	
ROCK CEDAR	3		2			
LIVE OAK	1		3			
POST OAK	4		3			
TEXAS OAK	2		3			
CEDAR OAK	2		3			
RARE / ENDANGERED SPECIES		5		5	25	
BIGTOOTH MAPLE	5		5			
PINCUSHION CACTUS	3		5			
MOUND CORY	1		5			
PEST SPECIES		3		1	3	
POISON IVY	3		1			
ECONOMIC VALUE		3		3	9	
ROCK CEDAR	[illegible]		[illegible]			
LIVE OAK	[illegible]		[illegible]			
Other		---		---	---	
—	—		—			

Total Area Value	22	Total Combined Resource Value	67

Figure 11. The "susceptibility to damage" approach to evaluating vegetation for tactical vehicle use.

the special rating form provides space for any remarks or notes which may be necessary to help evaluate an area.

Step 3, Relative Value. In this column of the evaluation form, rate each listed vegetation resource. The value of the resources at each site should be rated relative to their value on the rest of the installation. When determining this value, consider the past, present, and future carrying capacity of the area in relation to the rest of the installation. The relative value is determined using the five-point scale provided in Table 9.

Step 4, Categorical Value. Determine the "relative value" of each of the resource categories for which vegetation resources were identified. To do this, take the highest individual vegetation value under each category and assign that value to the entire category. For example, the "Dominant Tree Strata" resources in Figure 10 have been given relative values ranging from 1 to 4. Since "Post Oak" was given a value of 4, the highest "relative value" in the category, the entire category "Dominant Tree Strata" should be given a value of 4.

Step 5, Total Area Value. Determine the "relative value" of the entire area by adding the category values. For example, the total area value of 22 on Figure 10 was determined by adding the values for the categories "Dominant Ground Cover," "Dominant Tree Strata," "Rare/Endangered Species," "Pest Species," "Economic Value," and "Other."

Table 9

Rating Scale for the Evaluation of the "Relative Value" of Vegetation

Relative Value of the Vegetation Resource	Rating
The resource has little importance at this location when compared to the rest of the installation..	1
The resource has some importance at this location, but its value is somewhat below average as compared to the rest of the installation.........	2
The resource at this location is representative of the entire installation..	3
The area is one of the better examples of this resource relative to the rest of the installation. The value of the resource at this location can be described as somewhat above average.......................	4
This area is one of the very best examples of this resource as compared to the rest of the installation. The value of the resource at this location can be described as much more valuable than at other locations on the installation..	5

Step 6, Rating. Determine the overall "relative value" rating of the area by dividing the total area value by the number of resource categories for which values have been determined. In Figure 10, 22 has been divided by 6 for a value of 3.7. If the category "Other" had contained a value, the total area value would have been divided by 7. After determining the area rating, write it in the space provided near the top of the form. This allows for a quick comparison of alternative areas.

Step 7, Vegetation Limitation. For decision-making purposes, the vegetation limitations of the area must be noted. The vegetation limitation is the resource category which has received the highest "categorical value." For example, in Figure 10 the limitation for the hypothetical area is "Rare/ Endangered Species," particularly the "Big Tooth Maple." The vegetation limitation shows which resource places the greatest restriction on possible tactical vehicle use or clearing. When describing the limitation, briefly explain the importance of the resource. Word the explanation so that a nonbiologist can understand the logic.

Step 8, Rank. If alternative areas are being evaluated, the final step in this approach is to rank alternative sites. To do this, compare the biological ratings and limitation of each area. Rank the area with the lowest numerical rating No. 1. This indicates that of the alternatives examined, the area is the most acceptable for tactical vehicle training or for clearing operations. Rank the area with the second lowest rating No. 2. If two areas receive the same rating, use individual judgment to determine the importance of the biological limitations of the areas before assigning ranks. The area which has the more significant limitations will receive the higher numerical rank.

Through the use of the "relative value" approach, the value of the vegetation at a potential training site is quantified. The total area rating can be interpreted to indicate the potential loss to the installation if tactical vehicle training or clearing is allowed in the area. This is done by comparing the area rating with the statements used to rate each individual vegetation resource (Table 9). For example, if the total area rating of a proposal site is 2, then the vegetation resources at the site have some value, but their value is somewhat below average compared with the rest of the installation. Therefore, the area would likely be more acceptable than other sites. However, it would be wise to identify and stress the importance of those individual resources which received high "relative value" ratings. Certain appropriate mitigation procedures should be recommended to protect those resources if the area is used.

If an area received a total relative value rating close to 4, further examination of the site and alternatives may be required. A rating of 4 indicates that the area is one of the better examples of vegetation resources relative to the rest of the installation. Therefore, the area should probably not be the used. Any area which receives an overall rating greater than 4 should be considered unacceptable.

The "Susceptibility to Damage" Approach

For an indication of the potential impact of training activities, the user can extend the "relative value" approach to include estimates of probable damage. This is done with the "susceptibility to damage" approach, which is used only if the examiner feels qualified to estimate the degree of damage likely to occur to the vegetation resources of the area if a site is cleared and tactical vehicle training conducted. Susceptibility to damage will generally be a function of the amount of clearing required, the type of maneuvers conducted, and intensity of use.

A description of the "susceptibility to damage" approach follows.

Step 1, Initial Steps. The initial steps of this approach are the same as the first four listed in the "relative value" approach (p 61). After completing those steps, go on through the steps listed below.

Step 2, Susceptibility to Damage. Determine the susceptibility to damage of each of the biological resource categories and, in this column, assign a susceptibility value to each resource. Since the importance of damage to various resources is perceived differently, use the two separate scales provided on Tables 10 and 11 to assign the values. One scale applies to all resource categories except "Pest Species"; the other is used exclusively for "Pest Species."

Step 3, Categorical Susceptibility. Determine the "susceptibility to damage" for each resource category by assigning to the entire category the susceptibility value of that resource which received the highest relative value. For example, in Figure 11 the resource "Texas Grama" has a relative value of 3. Since it is the highest "relative value" for any resource in the category "Dominant Ground Cover," the entire category receives a "susceptibility to damage" value of 2, the susceptibility value for "Texas Grama."

Step 4, Combined Resource Value. Determine the combined resource value of each resource category by multiplying the relative values by the susceptibility to damage values. In Figure 11, the "relative value" of the category "Dominant Ground Cover," 3, is multiplied by the "susceptibility to damage" value, 2. This results in a combined resources value of 6. Determine the combined resource value of the entire area by adding the combined resource values for each category. In Figure 11, this results in a total combined resource value of 67.

Step 5, Rating. Determine the overall "susceptibility to damage" rating for the entire area by dividing the total combined resource value by the number of resource categories for which combined resource values have been determined. In Figure 11, 67 has been divided by 6 for a rating value of 11.2. (Note that if the category "Other" had contained a susceptibility value, the area's combined resource value would have been divided by 7.) As in the "relative value" approach, the area rating is placed in the space provided on the evaluation form.

Step 6, Vegetation Limitation. To help in the decision-making process, the vegetation limitation of an area must be recorded. Determine the limitation by examining the combined resource value of each resource category. The highest individual category value determines the vegetation limitation. In Figure 11, the limiting factor is "Rare/Endangered Species." This resource category has a combined resource value of 25, the highest of all categories. In this case, the presence of "Big Tooth Maple" (which will be significantly

Table 10

Rating Scale for the Evaluation of the "Susceptibility to Damage" of Nonpest Vegetation

Susceptibility to Damage of Nonpest Vegetation	Rating
This resource will receive some damage as a result of tactical vehicle use or clearing activities. Recovery time for the resource would be within 1 year; or the area is already so badly damaged from other factors that it has no logical present or future biological value	1
This resource will be damaged by tactical vehicles or clearing operations. Recovery time for this resource would be from 1 to 5 years	2
Tactical vehicle use or clearing would be destructive to this resource. Recovery time would be from 5 to 10 years	3
Tactical vehicle use or clearing would be highly destructive. Recovery time for this resource would be from 10 to 100 years	4
Tactical vehicle use or clearing would be extremely destructive to this resource. If use is allowed, the recovery time would be greater than 100 years	5

Table 11

Rating Scale for the Evaluation of the "Susceptibility to Damage" of Pest Species Vegetation

Susceptibility to Damage of Pest Species Vegetation	Rating
Tactical vehicle use or clearing would cause no increase in this species through habitat improvement or a reduction in competition; any prediction of decrease in the species is also indicated by a value of 1	1
Tactical vehicle use or clearing would cause a slight increase in this species	2
A moderate increase in this species is expected as a result of tactical vehicle use or clearing	3
A large increase in this species is expected as a result of tactical vehicle use or clearing	4
Tactical vehicle use or clearing would reduce competition or improve habitat for this species such that a very large increase in the pest population is expected	5

affected by tactical vehicle use or clearing) presents the greatest vegetation limitation.

Step 7, Rank. If alternative areas are being evaluated, they should be ranked. To do this, compare the overall rating for each area. Rank the area with the lowest numerical rating No. 1. The area with this ranking is the most acceptable. Any area which has a rating greater than or equal to 16 is not normally acceptable for use. A rating of 16 or greater indicates that the area contains generally better vegetation resources than the rest of the installation, and that tactical vehicle use or clearing operations on the site would be relatively more destructive to these resources.

For both the "relative value" and "susceptibility to damage" approaches, areas which receive very low ratings are more acceptable for tactical vehicle use or clearing operations. If several alternative areas are evaluated, the same rating approach should be used for each area. The area which receives the lowest numerical rating and is ranked No. 1 is the most acceptable for use in terms of minimizing the damage to the vegetation resources of the installation.

Mitigation Procedures

The impacts to vegetation as a result of tactical vehicle maneuvers will generally be unavoidable. The size, weight, and mode of movement of tactical vehicles will damage any grasses or shrubs passed over. Therefore, the first order mitigation technique is to choose training areas where the vegetation which will be affected is hardy and of average or lower value.

Second order mitigation techniques to reduce impact include the control of vehicle movements, trail maintenance and scheduling of maneuvers. When applicable, measures should be taken to ensure that vehicle movement is confined to designated trails. This can be done with proper signing of trails, trail maintenance, and operator education about the value of vegetation resources.* Where cross-country movements are required to accomplish the training mission, special programs might be established to educate vehicle operators. These should include information on the proper operation of vehicles -- e.g., avoiding tight, locked-track turns and deliberate damage to vegetation -- as well as information on the value of vegetation resources.

If possible, maneuvers should be scheduled during the time of the year when vegetation would be least susceptible to mechanical injury and damage. Scheduling should be given a high priority in areas where the vegetation is primarily shrubland, grassland, or desert. Training activities should be avoided, or at least reduced, during periods of high rainfall on the temperate plains or other humid areas, and during period of reduced rainfall (drought conditions) in arid or semi-arid areas.

Considerable vegetation damage can be caused at sites where timber must be removed to simulate combat conditions. Timber harvest or general clearing are the methods most commonly used for timber removal. Each method has

* Information applicable to trail maintenance techniques can be found in the references to Chapters 6 and 7 and in Appendix C.

advantages and disadvantages, both in terms of the efficiency and cost of removal and as a mitigation technique or source of material for providing mitigation.

Timber harvesting, which is generally done by contract, can be designed to selectively cut trees. Trees can be marked by installation personnel before harvesting or before the contract is let. Timber harvest has the advantage in that it is done at a profit, is generally less damaging to remaining trees, and can generally be done under the ongoing mission environmental impact statement for the installation. However, timber harvesting can be a slow process, taking many months from the time of the award of the contract until the harvest is complete.

General clearing, again usually done by contract, involves bulldozing all vegetation necessary to prepare the site to simulate combat conditions. In the past, the destroyed vegetation was piled and burned. The recent trend on many installations has been to push this debris into areas of significant topographic relief to reduce erosion. This provides good habitat for many species of endemic animals. Generally, a seeding program to produce some sort of ground cover is included with general clearing.

The advantage of general clearing is that it is much faster than timber harvesting. It is also easier to designate the vegetation which should remain. The disadvantages are many and some fairly severe. When the bulldozer blade touches the ground, ground cover vegetation, dead debris that covers the ground, and some soil are often removed. Even if the blade is kept off the ground, the vehicle's tracks and vegetation that is pushed over will disturb the soil surface. This will increase the possibility of severe water- or wind-aided erosion. Experience has shown that much damage is caused to remaining trees when equipment opens large "wounds" which allow easy access to pests and disease. In many cases, this leads to tree death and loss of the desired tree cover. Another disadvantage to this method is that, in the long term, it will cost more to clear areas instead of harvesting the timber. In addition, an environmental impact statement covering this operation will have to be prepared.

Erosion is the major problem caused by vegetation removal, and the one having the highest visibility and potential for adverse public reaction. Gullies provide ready evidence of erosion, as does soil leaving the installation in waterways or as wind-borne particulates. Although this problem has been addressed in earlier chapters, it is reemphasized here because loss of vegetation is the principal cause of erosion.

A vigorous plan of erosion control on training areas should be undertaken whether the area has been recently prepared for training or has been under long-term use. The first line of defense against erosion is adequate ground cover.* This can be established by a seeding program which broadcasts a mixture of grasses, herbaceous legumes, and some deciduous trees and shrubs. The

* Seeding and many other techniques for erosion control are discussed in detail in the references identified in Chapters 6 and 7 and Appendix C.

program should be coordinated with fish and wildlife, forestry, and agricultural outleasing personnel, and should be given a relatively high priority. In areas of long-term use, where the soil has been bare and erosion is already a problem, fertilizer may be required.

10 WILDLIFE

Wildlife Considerations

Wildlife plays an important role in the ecosystem of an area; tactical vehicle training can have a significant impact on wildlife.[27] The wildlife resources of a proposed training area should be examined to determine the relative value of the wildlife within the area, and, if possible, to consider the impact of training on these resources. All animal life, whether terrestrial or aquatic, should be considered. Terrestrial wildlife includes mammals, birds, reptiles, amphibians, insects and other invertebrates. Aquatic life includes members of these same groups and fish.

The major cause of damage to wildlife populations is the loss of habitat. When vegetation is lost, so are feeding and breeding resources. A second cause of wildlife population reduction is the actual disturbance of the animals' day-to-day routine. Tactical vehicle training can easily disrupt any of the basic animal activities such as feeding, mating, rearing of young, nesting, or resting. The results of this are that animals either leave the area or produce so few offspring that the population is not able to sustain itself.

Another result of training is the replacement of endemic wildlife by non-native, introduced species that are considered pests. In disturbed habitats, many intolerant species will receive competition from, and be replaced by, more tolerant species. It is generally true that rare, endangered, or uncommon species are intolerant of human activity and introduced species; e.g., the house mouse, Norway rat, black rat, and English sparrow are the more tolerant species. Even if the pest species do not force endemics out of training areas, the less tolerant endemics may leave the area, and the more tolerant endemics will be the only species remaining.

Evaluative Procedure

The following procedure can be used to evaluate the wildlife resources of a proposed training area. It is similar to the procedure described earlier to evaluate vegetation resources (Chapter 9). It also allows the wildlife to be evaluated by either of two approaches; i.e., the wildlife's "relative value" or "susceptibility to damage" is determined. The same constraints which should be applied to the vegetation evaluation are also applicable in this procedure -- e.g., for best results, the procedures should be completed by a professional biologist with field qualifications.

An example, using a hypothetical area, accompanies the instructions to each approach. Figure 12 illustrates the "relative value" approach. The "susceptibility to damage" approach is illustrated on Figure 13. A blank copy of the form used in Figures 12 and 13 is provided in Appendix B.

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[27] W. D. Severinghaus, R. E. Riggins, and W. D. Goran, Effects of Tracked Vehicle on Activity on Terrestrial Mammals, Birds and Vegetation at Fort Knox, KY, Special Report N-77/ADA073782 (CERL, July 1979).

(1) Area ARIA I

(6) Rating 10 Rank 5 (8)

WILDLIFE Limitation HUNTING/FISHING, PARTICULARLY PRESENCE OF WHITE-TAILED DEER AND RARE/ENDANGERED SPECIES, I.E., GOLDEN-CHEEKED WARBLER (7)

(2) Wildlife Resources	(3) Relative Value	(4) Categorical Value	Susceptibility to Damage	Categorical Susceptibility	Combined Resource Value	Notes
TERRESTRIAL SPECIES		3				
DEER MOUSE	2					
ARMADILLO	2					
PAINTED BUNTING	3					
TEXAS SPINY LIZARD	2					
AQUATIC SPECIES		4				
RED-EARED TURTLE	3					
GREAT BLUE HERON	4					
OLIGOCHAETES	2					
LONGNOSED GAR	2					
HUNTING / FISHING		5				
MOURNING DOVE	3					
WHITE-TAILED DEER	5					
BOBWHITE	4					
LARGEMOUTH BASS	4					
WHITE CRAPPIE	2					
CHANNEL CATFISH	3					
RARE/ENDANGERED SPECIES		5				
GOLDEN-CHEEKED WARBLER	5					
PEST SPECIES		3				
HOUSE SPARROW	3					
HOUSE MOUSE	3					
NORWAY RAT	3					
AESTHETICS		4				
SCISSOR-TAILED FLYCATCHER	4					
Other		–				
	—					
(5) Total Area Value		24	Total Combined Resource Value			

Figure 12. The "relative value" approach to evaluating wildlife resources.

Area AREA 1

(5) Rating 11.7 Rank 3 (7)

WILDLIFE Limitation HUNTING/FISHING, PARTICULARLY THE PRESENCE OF WHITE-TAILED DEER WHICH WOULD BE SIGNIFICANTLY AFFECTED. (6)

Wildlife Resources	(1) Relative Value	Categorical Value	(2) Susceptibility to Damage	(3) Categorical Susceptibility	(4) Combined Resource Value	Notes
TERRESTRIAL		3		2	6	
DEER MOUSE	2		2			
ARMADILLO	2		4			
PAINTED BUNTING	3		2			
TEXAS SPINY LIZARD	2		3			
AQUATIC		4		3	12	
RED-EARED TURTLE	3		2			
GREAT BLUE HERON	4		3			
OLIGOCHAETES	2		3			
LONGNOSED GAR	2		2			
HUNTING/FISHING		5		4	20	
MOURNING DOVE	3		4			
WHITE-TAILED DEER	5		4			
BOBWHITE	4		2			
LARGEMOUTH BASS	4		5			
WHITE CRAPPIE	2		3			
CHANNEL CATFISH	3		2			
RARE/ENDANGERED SPECIES		5		2	10	
GOLDEN-CHEEKED WARBLER	5		2			
PEST SPECIES		3		2	6	
HOUSE SPARROW	3		1			
HOUSE MOUSE	3		2			
NORWAY RAT	3		1			
AESTHETICS		4		4	16	
SCISSOR-TAILED FLYCATCHER	4		4			
Other				—	—	
—	—					

Total Area Value { | Total Combined Resource Value { 70

Figure 13. The "susceptibility to damage" approach to evaluating wildlife for tactical vehicle use.

Step 1, Area. Assign a special designation to each alternative area. These designations should represent the same areas as those used in the vegetation evaluation. If a candidate area represents two or more distinct wildlife communities, the areas covered by the different communities should be considered separately.

Step 2, Wildlife Resources. Several categories of wildlife resources are listed in this column -- e.g., "Terrestrial" and "Aquatic." Under each category, list specific wildlife resources known to exist either in the area being examined or on the installation -- e.g., "Red-eared Turtle," and "Great Blue Heron." If any terrestrial or aquatic wildlife are game species, they should be included in the category "Hunting/Fishing." If they are rare or endangered or pest species, or are aesthetically pleasing, they should be included in the other applicable categories. Any significant species or wildlife factor which is not easily categorized should be listed under the category "Other." The list of wildlife resources can be compiled from existing data, but a site visit is strongly recommended.

Step 3, Relative Value. In this column of the evaluation form, rate each listed wildlife resource. The value of the resources at each site should be rated relative to their value on the rest of the installation. When determining this value, consider the past, present, and future carrying capacity of the area in relation to the rest of the installation. The relative value is determined using the five-point scale on Table 12.

Step 4, Categorical Value. Determine the "relative value" of each of the resource categories for which wildlife resources were identified. To do this, take the highest individual wildlife value under each category and assign that value to the entire category. For example, in Figure 12 the wildlife resources "Deer Mouse," "Armadillo," "Painted Bunting," and "Texas Spring Lizard" have been given relative values of 2, 2, 3, and 2, respectively. Since "Painted Bunting" was given a value of 3, the highest "relative value" in the "Terrestrial" category, the entire category was given a value of 3.

Step 5, Total Area Value. Determine the "relative value" of the entire area by adding the category values. For example, the total area value of 24 in Figure 12 was determined by adding the values for the categories "Terrestrial," "Aquatic," "Hunting/Fishing," "Rare/Endangered," "Pest Species," "Aesthetics," and "Other."

Step 6, Rating. Determine the overall "relative value" of the area by dividing the total area by the number of resource categories for which values have been determined. In Figure 12, 24 has been divided by 6 for a value of 4.0. If the category "Other" had contained a value, the total area would have been divided by 7. After determining the area rating, write it in the space provided near the top of the form.

Step 7, Wildlife Limitation. Identify the wildlife limitation for the area. The wildlife limitation is the resource category or categories which have received the highest "categorical value." For example, as illustrated in Figure 12, the wildlife limitations for the hypothetical area are its value for "Hunting/Fishing," particularly as hunting grounds for "White-tailed

Table 12

Rating Scale for the Evaluation of the "Relative Value" of Wildlife

Relative Value of the Wildlife Resource	Rating
The resource has little importance at this location when compared to the rest of the installation	1
The resource has some importance at this location, but its value is somewhat below average as compared to the rest of the installation	2
The resource at this location is representative of the entire installation	3
The area is one of the very best examples of this resource relative to the rest of the installation. The value of the resource at this location can be described as somewhat above average	4
This area is one of the very best examples of this resource as compared to the rest of the installation. The value of the resource at this location can be described as much more valuable than at other locations on the installation	5

Deer," and the presence of a "Rare/Endangered" species, the "Golden-cheeked Warbler." The wildlife limitation identifies those wildlife resources which place the greatest restriction on the possible use of the area by tactical vehicles. When describing the limitations, briefly explain the importance of the wildlife resource(s).

Step 8, Rank. If alternative areas are being evaluated, the final step in this approach is to rank the alternatives. To do this, compare the biological ratings and limitations of each area. Rank the area with the lowest numerical rating, No. 1. This indicates that the area is the most acceptable for tactical vehicle use since it has the least overall "relative value" in terms of wildlife resources. Rank the area with the second lowest overall rating No. 2, and so on. If two areas receive the same rating, use individual judgment to determine the importance of the wildlife limitation of the areas, and assign rank numbers accordingly. The area which has the most significant limitation should receive the higher numerical rank.

The user of the "relative value" approach to wildlife evaluation will have quantified the value of the wildlife at alternative sites for training. The total area ratings can be interpreted to indicate the potential loss of wildlife if the proposed or alternative areas are opened to use. For the hypothetical example provided here, the overall rating of the area was 4.0. By comparing this rating with the statements on Table 12, it might be said that the area is one of the better examples of wildlife resources relative to the rest of the installation and should probably not be used by tactical vehicles. Any area that receives an overall rating greater than 4 should be considered unacceptable because of the value of the wildlife present.

While the results obtained with the "relative value" approach appear fairly valid, a much better indication of the potential impact to wildlife can be obtained if the estimates of "relative value" are extended to include estimates of the "susceptibility to damage" of wildlife resources. This can be done with the second approach in the procedure. However, it should only be used if the examiner feels qualified to estimate the degree of damage likely to occur to wildlife if the area is opened to use.

The "Susceptibility to Damage" Approach

Step 1, Initial. The first steps of this approach are the same as the first four listed in the "relative value" approach.

Step 2, Susceptibility to Damage. Determine the susceptibility to damage of each of the wildlife resources listed under the resource categories and assign a susceptibility value to each resource. Since the importance of damage to various resources is perceived differently, use two separate scales provided on Tables 13 and 14 to assign the values. One scale applies to all resource categories except "Pest Species"; the other is used exclusively for "Pest Species."

Step 3, Categorical Susceptibility. Determine the "susceptibility to damage" for each resource category by assigning to the entire category the susceptibility value of that resource which received the highest relative value. For example, in Figure 13, the resource "Painted Bunting" has a relative value of 3. Since it is the highest "relative value" for any resource in the category "Terrestrial," the entire category receives a "susceptibility to damage" value of 2, the susceptibility value of the "Painted Bunting."

Step 4, Combined Resource Value. Determine the combined resource value of each resource category by multiplying the relative values by the susceptibility to damage values. In Figure 13, the "relative value" of the category "Terrestrial," 3, is multiplied by the "susceptibility to damage" value, 2. This results in a combined resource value of 6. Determine the combined resource value of the entire area by adding the combined resource values for each category. In Figure 13, this results in a total combined resource value of 70.

Step 5, Rating. Determine the overall "susceptibility to damage" rating for the entire area by dividing the total combined resource value by the number of resource categories for which combined resource values have been determined. On Figure 13, 70 has been divided by 6 for a rating value of 11.7. (Note that if the category "Other" had contained a susceptibility value, the area's combined resource value would have been divided by 7.) As in the "relative value" approach, the area rating is placed in the space provided on the evaluation form.

Step 6, Wildlife Limitation. To help in decision making, the wildlife limitation of an area must be recorded. Determine the limitation by examining the combined resource value of each category. The highest individual category value determines the biological limitation. In Figure 13, the limiting factor

Table 13

Rating Scale for the Evaluation of the
"Susceptibility to Damage" of Nonpest Wildlife

Susceptibility to Damage of Nonpest Wildlife	Rating
This resource will receive some damage as a result of tactical vehicle use. Recovery time for the resource would be within 1 year; or the area is already so badly damaged from other factors that it has no logical present or future wildlife value..................	1
This resource will be damaged by tactical vehicle use. Recovery time for the resource would be from 1 to 5 years.................	2
Tactical vehicle use would be destructive to this resource. Recovery time would be from 5 to 10 years................................	3
Tactical vehicle use would be highly destructive. Recovery time for this resource would be from 10 to 100 years......................	4
Tactical vehicle use would be extremely destructive to this resource. If use is allowed, the recovery time would be longer than 100 years...	5

Table 14

Rating Scale for the Evaluation of the
"Susceptibility to Damage" of Pest Species Wildlife

Susceptibility to Damage of Pest Species Wildlife	Rating
Tactical vehicle use would cause no increase in this species through habitat improvement or a reduction in competition; or any prediction of decrease in the species is also indicated by a value of 1..	1
Tactical vehicle use would cause a slight increase in this species...	2
A moderate increase in this species is expected as a result of tactical vehicle use..	3
A large increase in this species is expected as a result of tactical vehicle use..	4
Tactical vehicle use would reduce competition or improve habitat for this species such that a very large increase in the pest population is expected..	5

is "Hunting/Fishing." This resource category has a combined resource value of 20, the highest of all categories. In this case, the presence of "White-tailed Deer" (which will be significantly affected by tactical vehicle use) presents the greatest restriction.

Step 7, Rank. If alternative sites are being evaluated, they should be ranked by comparing overall rating for each area. Rank the area with the lowest numerical rating, No. 1. The area with this ranking is most acceptable for tactical vehicle use in terms of the potential effect on wildlife. Any area which has a rating greater than or equal to 16 is not normally acceptable for use. A rating of 16 or greater indicates that the area contains generally better wildlife resources compared to the rest of the installation and that tactical vehicle use or the activities involved in tactical vehicle use would be relatively more destructive to these resources.

If several alternative areas are evaluated, the same rating technique, either the "relative value" or "susceptibility to damage" approach to evaluating wildlife, should be used for each area. This makes the results comparable.

Mitigation Procedures

Proper site selection is the most important technique for reducing the impact of tactical vehicle training on wildlife. Areas should be chosen where both the "relative value" and "susceptibility to damage" of wildlife resources are low.

The major cause of damage or impact to wildlife populations is loss of habitat and feeding areas. Therefore, most of the techniques described in Chapter 9 for reducing the effects of training on vegetation will also limit impacts to wildlife. These techniques include control of vehicle movement, trail maintenance, scheduling of maneuvers, and the implementation of a vigorous program of erosion control through revegetation.

If feeding areas are lost to tactical vehicle training, erosion control through revegetation might include plantings for wildlife food plots. Plots might be established both in and next to the maneuver area. Those next to the area would relieve some of the stress on existing food sources created by wildlife as they leave the maneuver area. In addition, revegetation might include other habitat improvements for displaced species, e.g., plantings to create nesting areas.

Scheduling training activities to allow time for the necessary life functions of endemic wildlife can be very effective for maintaining wildlife populations. In particular, training activities might be avoided during the high points of the breeding season and periods of climatic stress. This will require a coordinated effort between training and natural resource personnel. Proper scheduling, reduced training activities, and habitat reconditioning will also help lessen problems of loss of intolerant species and increases in pest species.

11 INFORMATION DISPLAY AND TRANSFER

This chapter describes a simple technique for summarizing information obtained from the evaluation procedures. The technique emphasizes comparison of alternative areas. It is highly recommended that alternative areas be considered; for best results, at least two alternatives should be chosen. These areas can be selected after coordination with the various offices involved in training or land management, or after preliminary analysis of a proposed site.

If it is not possible to consider alternatives, the summary technique can still be used. However, this will require modifying the information display format. The modification and suggestions for preparing a summary of an environmental analysis of one area are discussed later in this chapter.

Information Summary and Comparison

To summarize the results of the evaluation procedures and compare alternatives, a form similar to that shown in Figure 14 should be prepared. This is not an official form for recording actions or approvals, it was developed specifically for use with the evaluation method in this report. Each Army Major Command (MACOM) has its own official method for transmittal of environmental analysis related to establishing training areas; these methods are to be used when applicable. Information on the summary analysis form provided here can be used in official MACOM transmittal methods as appropriate.

Conflicts

The form in Figure 14 provides space to identify conflicts between proposed training and each environmental resource element described in the previous chapters. Conflicts are impacts or site characteristics which may make the proposed site unacceptable. For example, a proposed route to and from a proposed training area may include a segment along a perimeter road, adjacent to off-post residential housing. This segment of the route may be within the calculated DNNA for housing (Chapter 4). The potential conflict to be identified on the summary analysis form might be stated as follows:

"Conflict with housing along perimeter segment of access trail."

An example of a training area conflict with vegetation might be stated:

"Conflict with dominant shrub strata, especially fragrant sumac."

Depending on the approach used to evaluate the vegetation of an area (Chapter 8), the latter statement can have two meanings. Under the "relative value" approach, this statement would imply that fragrant sumac, a dominant shrub, is considered a valuable vegetation resource and the area contains one of the better examples of this resource on the installation. Under the "susceptibility to damage" approach, the statement would imply that the area contains the relatively valuable resource, fragrant sumac, which is very susceptible to damage.

Preliminary Environmental Analysis of the Proposed Tactical Vehicle Training Area and Selected Alternatives

Environmental Resource Element	Proposed Area		Alternative Area 1[1]		Alternative Area 2	
	Rank[2]	Conflicts[3] and Mitigations	Rank	Conflicts and Mitigations	Rank	Conflicts and Mitigations
LAND USE						
NOISE						
TERRAIN						
SOIL						
AIR QUALITY						
WATER QUALITY						
VEGETATION						
WILDLIFE						

1 The location of the proposed and selected alternative areas are shown on the attached topographic maps.

2 Rank is a qualitive rating of suitability among alternatives. Areas ranked No. 1 are most acceptable. Areas ranked No. 3 are least acceptable.

3 The first entries are conflicts; the second entries are suggested mitigations

RECOMMENDATION:

Figure 14. Summary analysis and comparison form.

To complete the conflicts section of the form, potential [illegible]cts or unsuitable site characteristics related to each environmental resource element should be identified for each alternative area. As many conflicts as possible should be listed for each resource. At a minimum, the important or major conflicts should be listed. Major conflicts with each resource are:

1. Land Use. The major conflicts would be those land uses which received the high potential effect ratings with the procedure described in Chapter 3. Those with highest potential effect ratings should be listed first.

2. Noise. Conflicts associated with noise are those land uses located closer than the DNNA for their particular maximum acceptable noise level requirement. Major conflicts are those land uses closest to the noise source relative to the appropriate DNNA. Temporary or permanent troop housing directly adjacent to a proposed maneuver area would represent more of a conflict than the same housing located within 1640 ft (500 m) of the area, even though both might be closer than the appropriate DNNA. The type of noise-sensitive land use is also a consideration in identifying major conflicts; i.e., conflicts with housing are more significant than those with agricultural or grazing land uses.

3. Terrain. Major terrain conflicts are any significant acreage of unsuitable terrain characteristics which a site exhibits. Unsuitable slopes and water table considerations are the primary characteristics to be considered as major conflicts since they are the most severe factors limiting use.

4. Soil. The considerations in identifying major soil-related conflicts are the degrees of soil limitations and extent of coverage of soils with the greatest degree of limitation. If most of the area contains silt or silt loam soils (generally a severe limitation), the conflict might be stated as, "Considerable silts and silt loams -- poor trafficability, high erodibility." (Refer to Table 6.) If the area contains some silts and silt loams but is predominantly covered by silty clay or sandy clay loam, the conflict might be stated, "Considerable silty clays and sandy clay loams -- fair trafficability, moderate erodibility."

5. Air Quality. Potential air quality conflicts are those site characteristics which are identified as unsuitable. In order of importance (most to least), these characteristics are soils susceptible to erosion, land use conflicts, lack of windbreaks, and seasonal characteristics. Therefore, a major conflict would be the presence of unsuitable soils or those with a high susceptibility to wind erosion. If the soils of an area are found to have slight to moderate susceptibility to wind erosion, the presence of any other unsuitable site characteristic should be emphasized as a major conflict, e.g., "Dust sensitive housing area within 3280 ft (1000 m) of trail."

6. Water Quality. Major water quality conflicts are also the presence of unsuitable site characteristics -- e.g., highly erodible soils; large numbers of streams with excellent water quality; long, steep slopes near possible stream crossings. The relative significance of the unsuitable site characteristics depends on site specifics and comparability with alternative sites or the rest of the installation.

7. Vegetation. The major vegetation conflict would be the vegetation limitation identified by the evaluative procedure described in Chapter 9.

8. Wildlife. The major wildlife conflict would be the wildlife limitation identified by the evaluation procedure described in Chapter 10.

If a particular environmental resource element of an alternative area exhibits no particular conflict with tactical vehicle training, this should be noted on the environmental analysis form. This should be identified in the conflict section with the statement, "No conflict." As an example, suppose that an access trail and maneuver area for proposed training is located so that all noise-sensitive land uses are at distances equal to or greater than appropriate precalculated DNNAs. If this is the case, there should be no conflict with vehicle noise. (Note, however, that blast noise was not considered in the procedure provided in this report.)

If an area exhibits many suitable site characteristics for a particular environmental resource, this should also be noted. For example, suppose that an area being evaluated has slopes that do not normally exceed 30 percent, low value vegetation which will require no site preparation but is good ground cover for soil stabilization, few streams, and a water table greater than 4 ft (1.2 m). This site would be acceptable in terms of terrain characteristics (Chapter 5). Therefore, the statement made in the conflicts section for terrain might be, "No conflict -- exhibits suitable terrain characteristics."

When identifying environmental conflicts (especially major conflicts) for alternative training areas, it is important to try to consider the whole picture. For example, seldom-used outlying barracks near one alternative maneuver area are less significant as a conflict than family housing located next to the proposed maneuver area of another alternative. Similarly, if the major vegetation conflict of one alternative area is the presence of a species with moderate value or susceptibility to damage, this conflict should not receive the same weight as the presence of a rare or endangered species in an alternative area.

Ranking

Once conflicts have been identified for each environmental resource, the alternative areas examined are ranked relative to their acceptability for use. These ranks are based on the relative amount of conflict for each alternative area and are assigned separately for each environmental resource. In other words, the relative acceptability (rank) of each alternative area is determined for each resource without consideration of the acceptability of any other resource. The appropriate ranks are placed in the space provided on the summary analysis form.

If three alternative areas are examined, there are three possible ranks for the acceptability of an area: 1, 2, or 3. The rank of 1 is assigned to the most acceptable area, and indicates that the potential environmental conflict in that particular area is less significant than the conflict in the other areas examined. A rank of 2 indicates that the conflict is more significant but still less than that in the area ranked 3.

For example, suppose three tactical vehicle training areas are being considered. After evaluating the terrain characteristics of all three, it is determined that Area A has the greatest number of unsuitable terrain characteristics, Area B has the fewest unsuitable terrain characteristics, and Area C has a number somewhere between Areas A and B. Area B should be ranked 1 and Areas C and A should be ranked 2 and 3, respectively. This implies that Area B is the most acceptable area for tactical vehicle use in terms of terrain characteristics. (Note, however, that Area B may be the least acceptable overall since this rank only applies to terrain characteristics.)

The ranking method or scheme for each environmental resource that should be examined is described in the following paragraphs.

1. Land Use. The most acceptable alternative area in terms of land use is the one receiving the lowest overall potential effect rating (Chapter 3). The area with the lowest ranking is ranked 1, the area with the second lowest rating is ranked 2, and so on. The area with the highest rating and rank is the least acceptable for use.

2. Noise. The most acceptable alternative area in terms of noise has the least conflict with noise-sensitive land use. The area with the least conflict has the fewest noise-sensitive land uses located closer than appropriate DNNAs (Chapter 4). When determining the relative rank of areas, the special conditions discussed in *Conflicts* (p 79) should be considered.

3. Terrain. The alternative area with the fewest unsuitable terrain characteristics (Chapter 5) would be the area that is most acceptable for tactical vehicle use, and should be ranked 1. Again, the relative severity of unsuitable characteristics as described in Chapter 5 and in *Conflicts* (p 79) should be considered.

4. Soil. Based on the soil limitations mapping procedure (Chapter 6), the most acceptable area for use in terms of soils would be the one having the greatest percent of acreage with soils that have slight limitations. If all areas examined have small amounts of acreage with slight limitations, the most acceptable area would be one with the greatest percent of acreage with soils having slight and moderate limitations. The least acceptable area would be one having the greatest percentage of acreage with soils having severe limitations. If areas have similar amounts of acreage and soils with similar limitations, the relative degrees of limitation for each soil texture, as discussed in Chapter 6, should be considered.

5. Air Quality. The alternative area with the fewest characteristics which negatively affect air quality (Chapter 7) would be the most acceptable area and would be ranked 1. The area with the most unsuitable characteristics would be the least acceptable. Soil texture is a major factor in determining the suitability of an area and should receive primary consideration when weighing the amount of potential conflict an area exhibits.

6. Water Quality. As with terrain and air quality, the most acceptable area in terms of water quality conflict is one which exhibits the fewest unsuitable site characteristics.

7. Vegetation. The most acceptable area in terms of vegetation would be one with the lowest overall "relative value" or "susceptibility to damage" rating (Chapter 9). The least acceptable would have the highest rating.

8. Wildlife. The most acceptable area in terms of wildlife conflict would also be the one with the lowest "relative value" or "susceptibility to damage" rating (Chapter 10). The least acceptable area would have the highest rating.

The ranking schemes described above generally refer to conflicts and unsuitable site characteristics. Obviously, areas exhibiting no conflict or unsuitable site characteristics relative to a particular environmental resource should be considered most acceptable for that particular resource.

Mitigations

Further completion of the summary analysis form requires the identification of mitigation procedures. At least one suggested mitigation should be provided for each major conflict identified. Most mitigation procedures have been described briefly in the final sections of Chapters 3 through 10. (References for more detailed explanation of most procedures have also been provided.) These descriptions generally indicate the impact (conflict) or unsuitable site characteristic to which the procedures can be applied. From this information, the user should choose mitigation techniques. The technique should be briefly described in the space provided on the summary analysis form.

For example, consider the conflict statement used as an example earlier, "Conflict with housing along perimeter segment of access trail" (p 79). Several noise mitigation techniques could be applied here. If there is a possibility of an alternate route for the access trail without creating additional noise or other conflicts, the mitigation might be stated as follows: "Alter perimeter segment of access trail." This would appear on the summary analysis form as illustrated by A on Figure 15.

If there is not an alternative trail segment available so that conflict would be avoided, then speed limits might be established. The appropriate speed limit can be determined with the nomographs and procedure provided in Chapter 4 (p 24). If this speed limit were 20 mph (33 km/hr), then the appropriate mitigation statement would appear as illustrated by B on Figure 15.

If establishing a speed limit still would not control the noise conflict, then an additional mitigation procedure might be recommended -- e.g., noise barriers between the access trail and housing. The appropriate type and size of the barrier could be determined with information described in TM 5-803-2.[28] (For the summary analysis, it would not be necessary to actually determine the technical details of barrier size, but this should be done before any official environmental documentation concerning the proposed training area is prepared.) The appropriate mitigation statement for this procedure might appear as illustrated by C on Figure 15.

[28]TM 5-803-2, pp 5-43 through 5-51.

A

Environmental Resource Element	Proposed Area: Rank[2]	Conflicts[3] and Mitigations	
LAND USE			
NOISE	2	1. Conflict with housing along perimeter segment of access trail	
		1. Alter perimeter segment of access trail	
TERRAIN			

B

Environmental Resource Element	Proposed Area: Rank[2]	Conflicts[3] and Mitigations	
LAND USE			
NOISE	2	1 Conflict with housing along perimeter segment of access trail	
		1. Est. 20 mph speed limit	
TERRAIN			

C

Environmental Resource Element	Proposed Area: Rank[2]	Conflicts[3] and Mitigations	
LAND USE			
NOISE	2	1. Conflict with housing along perimeter segment of access trail	
		1. Est. 20 mph speed limit 2. Const. noise barriers	
TERRAIN			

Figure 15. Sample statements of noise conflicts and mitigations for preliminary environmental analysis.

Mitigation procedures should only be chosen and recommended if there is a possibility of implementing them. In addition, procedures should be chosen which will mitigate the most conflict. For example, a minor modification or adjustment in the boundary of an area may mitigate major conflicts with land use, noise, and air quality. If this is the case, the boundary adjustment can be considered a primary mitigation technique and one which should be strongly recommended.

Many erosion control and soil management procedures can be considered primary mitigation techniques. Erosion control and soil management procedures not only help preserve soil resources, they also help reduce impacts associated with air and water quality. In addition, certain control measures, specifically revegetation programs, also help maintain the value of vegetation resources and preserve wildlife habitat.

Selecting dual or combined procedures may increase the probability that they will be implemented. The most applicable combination is site selection or operational approaches combined with procedures which will require an actual mitigation program or task. For example, the establishment of a speed limit combined with construction of a noise barrier is a dual mitigation approach. The speed limit is the operational procedure. Lowering speeds should reduce the size and construction costs of any barrier.

Proper scheduling of activities is an operational procedure which can be combined with most programs or tasks to provide effective mitigation. For example, if training in humid or temperate climates is scheduled to avoid the wet season, the need for and cost of water quality and erosion control measures may be reduced. Similarly, if training is scheduled to avoid the dry season in arid climates, the need for and cost of application of dust palliatives may be reduced.

Comparison

Once conflicts, area acceptability for different resources, and mitigation procedures have been entered on the summary analysis form, the alternative areas can be compared. Through this comparison, the area that has the greatest overall acceptability for tactical vehicle use can be identified. The summary analysis form should make this identification fairly simple.

To make the comparison, several factors should be considered. The ranks given to each area for each environmental resource are one set of factors. If one particular area was consistently ranked number 1 in terms of resource acceptability, then it is probably the most acceptable area. Conversely, if one particular area was consistently ranked the least acceptable for each resource then it is probably the least acceptable. However, rank is based on separate comparison of each individual resource. Therefore, the actual conflicts identified are other factors to be considered.

Based on an examination of the conflicts, it may be found that a site consistently ranked 1 is not acceptable at all, and that a site which received relatively moderate ranks is actually more acceptable. For example, in comparing several areas, the user might find that conflicts for one area are fairly moderate -- i.e., the area was ranked 2 in acceptability for most of the eight environmental elements. For another area, each environmental element except one may have been ranked 1 in terms of acceptability. If the one element not ranked 1 was found extremely valuable or susceptible to severe damage -- e.g., a rare/endangered species -- then the site with moderate conflicts may be more acceptable.

Using the same example, the likelihood that the area with moderate conflicts is more acceptable is even greater if there is little relative difference between the other conflicts for the two areas and there is no acceptable procedure available to reduce the potential impact to the extremely valuable or susceptible resource. For this reason mitigation procedures' availability and ease of implementation are additional factors to be considered.

Certain procedures are more easily carried out than others. For example, operational procedures -- e.g., speed limits, scheduling, or any control of vehicle movement -- are generally more easily implemented than program or task procedures: sound barrier construction or large-scale revegetation programs, for example. Therefore, if ranks for two areas are very similar, the more acceptable area for consideration might be the one for which controlling impacts on resources will be easier.

If all factors are taken into account, the examiner should be able to determine overall acceptability of alternative areas. This determination and all other information on the summary analysis form will become the basis for recommendations.

Making Recommendations

The preliminary environmental analysis form provides space for recommendations and can be used to transfer information to the decision-maker. It is recommended that the form, or a similar one, be used since it provides the argument for the recommendation.

Any recommendations should be based on the severity of resource conflict and the comparison of the acceptability of alternative areas. Thus, there are two basic options for making a recommendation. First, if the potential impact or conflict for all areas examined is considered too severe, then an examination of other alternative areas can be recommended. This may not be possible for many installations because of the size and availability of land. Second, based on the completion of the evaluation method, the most acceptable area for use can be recommended.

For either option, certain facts and suggestions should accompany the recommendation. First, all major conflicts requiring long-term, large-scale, or expensive mitigation procedures should be identified. A brief description of the necessary mitigation procedure should be included. Any major impact or conflict which cannot be successfully and significantly reduced should be identified. A brief statement describing the advantages of the recommendation over other available options or alternatives should also be included. Finally, suggestions for completing further detailed evaluation and an environmental assessment for the proposed use area should be made.

Evaluation Without Alternatives

The procedures and evaluation method described in this report are best suited for comparison of alternative areas. However, it is anticipated that in many instances there will be no consideration of alternatives beyond slight modification to the proposed area. This may include minor boundary changes, alternative access routes, and variations in vehicle operation -- e.g., scheduling.

There are three primary reasons for this. First, tactical vehicle training generally requires a lot of land. Many installations do not have enough acreage to allow for the evaluation of several distinct alternative areas. Second, the primary use of the evaluative method may be to assess an action before actually proposing it. Persons in the installation DPT office will normally use the procedure in this way. Finally, other personnel -- i.e., master planning, natural resource, and environmental personnel -- who are to provide input on a proposed action may be asked to consider only that action.

In these cases the evaluation procedures provided here are still applicable. However, the information display and transfer techniques should be modified. Additional considerations related to the severity of environmental conflict and implementation of mitigation procedures are also required. Figure 16 illustrates a summary analysis form which can be used for evaluating a single area.

To complete the single area summary analysis form, the user should apply the evaluative procedures described in the previous chapters. Potential effect on land use and on vegetation and wildlife ratings for the one area should be determined. Major limitations related to these resource ratings should be identified. All unsuitable terrain, air, and water quality characteristics for the area should be described. Appropriate soil limitations maps for the area should be prepared and all noise-sensitive land uses identified.

Once this is done, the impacts, conflicts, and unsuitable site characteristics should be listed on the form. For evaluation of a single area, all possible impacts are potentially important and should be listed. After this, techniques to reduce impacts and conflicts should be identified. The same considerations for selecting mitigation procedures discussed earlier apply.

In an assessment of alternative areas, the major impacts, conflicts, or unsuitable site characteristics of a particular area stand out because they generally vary from site to site and can be compared. However, no basis of comparison is available when a single site is evaluated and an identified conflict could be minor or extremely significant. For this reason, all possible impacts, conflicts, unsuitable site characteristics, and mitigation procedures are determined. Once they have been identified and placed on the summary analysis form, any special considerations can be noted. These considerations are related to the severity of impact and are also the basis for making recommendations.

The descriptions of the evaluation procedures for each environmental element generally describe conditions or characteristics which cause the most significant impact or can be most significantly affected. For example, slope and water table are the terrain characteristics which would result in the most

Preliminary Environmental Analysis of the Proposed
Tactical Vehicle Training Area

Environmental Resource Element	Special[1] Consideration	Potential Conflicts	Suggested Mitigation
LAND USE			
NOISE			
TERRAIN			
SOIL			
AIR QUALITY			
WATER QUALITY			
VEGETATION			
WILDLIFE			

[1] Designated resources deserve special consideration due to severity of potential conflicts.

RECOMMENDATION:

Figure 16. Summary evaluation form.

significant impacts. Areas with slopes that normally average or exceed 30 to 35 percent are considered very unsuitable for use, as are areas with water tables generally at a depth of less than 4 ft (1.2 m). If the proposed training area exhibits these characteristics, it would be very unsuitable in terms of terrain characteristics. Other unsuitable terrain characteristics are less significant. Therefore, slope and water table deserve special consideration. Similiarly, the rating procedures for both vegetation and wildlife identify conditions which make an area very unsuitable. If the proposed training area receives a rating value of 4 for "relative value" or 16 for "susceptibility to damage," then it is very unsuitable. The resource, either vegetation or wildlife, which receives this rating deserves special consideration.

Figure 17 summarizes the major conditions or characteristics which cause each environmental resource to deserve special consideration. If any of these resource characteristics exist in the area being examined they should be identified by writing the conditions or characteristics in the special consideration space provided on the summary analysis form.

When special considerations are identified, recommendations related to the suitability of the area and conditions for use can be made. At a minimum, these recommendations should briefly describe the resources which should receive special consideration if the area is used. Appropriate procedures for reducing the effects of this use on resources should be included and strongly recommended. If conflicts or impacts associated with these resources cannot be significantly reduced, this should be noted.

More substantial consideration of environmental and natural resources can be made if moderate and minor conflicts can also be identified and included in the recommendation. Appropriate mitigation procedures should be identified for conflicts as necessary. The more detail that can be provided, the greater the likelihood that the decision will be made with sensitivity for natural resources and the environment.

When Evaluating Areas for Possible Tactical Vehicle Use, the Environmental Resource:	Deserves Special Consideration if:
Land Use	1. Any land use on or next to the area has a potential effect rating of greater than or equal to 4.
Noise	1. Any nearby noise-sensitive land use with a maximum acceptable noise level requirement of less than or equal to 70 decibels (dBA L_{eq}) is located closer to the area than the Distance Necessary for Noise Attenuation (DNNA).
Terrain	1. The area has topography where the average degree of slope normally exceeds 30 to 35 percent. OR 2. The water table in the area is generally at a depth of less than 4 ft (1.2 m).
Soil	1. More than 50 percent of the area has soils with severe limitations.

Figure 17. Special considerations for tactical vehicle training area suitability.

When Evaluating Areas for Possible Tactical Vehicle Use, the Environmental Resource:	Deserves Special Consideration if:
Air Quality	1. More than 50 percent of the area has soils that are clays, silts, silty clay loams, or silty clays. OR 2. More than 75 percent of the route to the area has soils that are sandy clays, loams, clay loams, silt loams or one of the textures in 1 above. OR 3. Any dust-sensitive land use is located within 3280 ft (1000 m) of the area or route to the area. OR 4. The area is located in an arid climate.
Water Quality	1. Stream crossing is required, unless streams are intermittent. OR 2. More than 50 percent of the soils located within 3280 ft (1000 m) of streams or pond have severe limitations.
Vegetation	1. The area contains a rare, threatened, or endangered plant species. OR 2. The "relative value" rating for the vegetation in the area is equal to or greater than 4. OR 3. The "susceptibility to damage" rating for the vegetation in the area is equal to or greater than 16.

Figure 17. Cont'd.

When Evaluating Areas for Possible Tactical Vehicle Use, the Environmental Resource:	Deserves Special Consideration if:
Wildlife	1. The area contains a rare, threatened, or endangered wildlife species. OR 2. The "relative value" rating for the wildlife in the area is equal to or greater than 4. OR 3. The "susceptibility to damage" rating for the wildlife in the area is equal to or greater than 16.

Figure 17. Cont'd.

12 CONCLUSION

The criteria and methods for land and natural resource evaluation described in this report will help Army personnel select areas which can be used for tactical vehicle training. The criteria take into account eight general categories of land and natural resources: land use, noise, terrain, soil, air quality, water quality, vegetation, and wildlife. While environmental and natural resource protection is the focus of the procedures, the training mission is also a consideration.

The procedures were designed to be as nontechnical as possible. Therefore, they may be applied by persons with varying degrees of expertise in environmental and natural resource management. Anticipated users include personnel in installation DPT, environmental, natural resource, and master planning offices. Personnel in the installation DPT office can use the methods before proposing areas for training. Other personnel can apply the methods when providing information on the environmental acceptability of proposed training areas.

While the procedures can not take the place of a detailed environmental assessment, they will help identify potential environmental damage or conflict. This can reduce delay in establishing a tactical vehicle training area, and can provide more environmentally sensitive decision-making.

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AD-A103 276 CONSTRUCTION ENGINEERING RESEARCH LAB (ARMY) CHAMPAIGN IL F/G 5/1
NATURAL RESOURCE CONSIDERATIONS FOR TACTICAL VEHICLE TRAINING A--ETC(U)
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APPENDIX A:

MILITARY VEHICLES AND SOIL CONSIDERATIONS

Table 6 of this report (p 43) provides rating criteria to evaluate soils for tactical vehicle use. It was developed from information obtained from trafficability studies performed by the U.S. Army Engineer Waterways Experiment Station (WES), and from soil erosion factors developed by the USDA, SCS. The rating criteria, as they appear in the report, are primarily applicable to evaluating soils for use by vehicles which fall into a category including most all-wheel-drive trucks, a great number of trailed vehicles, and heavy tanks.

This category of vehicles is identified in WES trafficability studies as category 5. Vehicles in other categories are either more or less capable of travelling over certain soils and more or less damaging to soils. Therefore, if the vehicles expected to participate in proposed maneuvers are generally in a different category, the rating criteria may need to be adjusted. This adjustment is discussed on p 45.

Table A1 identifies the various categories of tactical vehicles in terms of trafficability. Table A2 lists examples of the types of vehicles in each category. The vehicle categories in Table A1 are arranged in order of their ability to traverse fine-grained soils without becoming stranded. This order also indicates the relative degree of impact to the soils that the vehicles will produce. Vehicles in category 1 are less likely to become stranded and cause damage to soils. If the vehicles involved in exercises at a proposed training area are generally in a category lower than 5, then the severity of the soil limitations can be considered slightly less than that illustrated on Table 6. However, the order of severity of limitation remains the same.

Table A1

Categories of Tactical Vehicles

Category	Vehicles
1	Lightweight vehicles with low contact pressures (less than 2.0, psi).
2	Engineer and high-speed tractors with comparatively wide tracks and low contact pressures.
3	Tractors with average contact pressures, tanks with comparatively low contact pressures, and some trailed vehicles with very low contact pressures.
4	Most medium tanks, tractors with high contact pressures, and all-wheel-drive trucks and trailed vehicles with low contact pressures.
5	Most all-wheel-drive trucks, a great number of trailed vehicles, and heavy tanks.
6	A great number of all-wheel-drive and rear-wheel-drive trucks, and trailed vehicles intended primarily for highway use.
7	Rear-wheel-drive vehicles and others that generally are not expected to operate off roads, especially in wet soils.

Table A2

Types of Vehicles in Various Tactical Vehicle Categories

Tracked Vehicles

Vehicle Description	Category
Amphibious Vehicles	
Assault vehicle, full tracked, amphibious M733 FSN 2320-999-4312	1
Carrier, cargo, amphibious, tracked: M116	1
Landing vehicle, tracked MK4; armored MK4; engineer M1 (LVTE1); command M5 (LVTP5A1(CMD)); personnel M5 (LVTP5A1); howitzer M6 (LVTH6A1); recovery M1 (LVTR1A1);	2
Tank, combat, full tracked: counter-insurgency, amphibious, lt wt, M729 FSN 2350-921-5564	1
Armored Bulldozers	
Bulldozer, earthmoving M6, tank mtd (tank, combat, 90 mm gun M47); earthmoving M8 (tank, combat, 90mm gun M48); earthmoving tank mtd, M9 (tank, combat, 105mm gun, M60 and M60A1)	3
Combat Vehicles	
Armored reconnaissance airborne assault vehicle (General Sheridan) M551	2
Flamethrower, self-propelled M132; M132A1	2
Gun, antiaircraft artillery, self-propelled: twin 40mm M19A1; M42; M42A1	2
Gun, field artillery, self-propelled, 155mm, M53 (T97)	2
Gun, antitank, self-propelled 90mm, M56	1
Gun, field artillery, self-propelled: 175mm, M107 (T235E1)	3

Table A2 (Cont'd)

Tracked Vehicles -- Continued

Vehicle Description	Category
Howitzer, heavy, self-propelled, full tracked 8 inch M55 (T108)	2
Howitzer, heavy self-propelled: 8 inch M110 (T236E1)	2
Howitzer, light, self-propelled, full tracked 105mm, M37; M52; M52A1	2
Howitzer, light, self-propelled: 105mm, M108 (T195E1)	2
Howitzer, medium, self-propelled, full tracked 155mm, M44; M44A1	2
Howitzer, medium, self-propelled: 155mm, M109 (T196E1)	3
Mortar, infantry, self-propelled, full-tracked: 107mm, (4.2 inch) M84	2
Rifle, self-propelled, full tracked: multiple, 106mm M50	1
Tank, combat, full tracked: 105mm gun, M60; M60A1	2
Tank, combat, full tracked: 120mm gun, M103; M103A1	3
Tank, combat, full tracked: flamethrower, M67A1	3
Vehicle, combat, engineer full tracked: 165mm gun, M728 (basic M60A1 tank) FSN 2350-795-1797	4
Armored Vehicle Launched Bridges	
Launcher, M60A1 chassis, transporting	2
Launcher, M60A1 chassis, transporting, with bridge, armored vehicle launched, scissoring type, class 60: 60-foot	3

Table A2 (Cont'd)

Tracked Vehicles -- Continued

Vehicle Description	Category
Carriers	
Carrier, cargo, tracked: 6 ton M548	2
Carrier, command post, light, tracked: M577; M577A1	2
Carrier, command and reconnaissance, armored: M114A1; M114	1
Carrier, guided missile equipment, full tracked: M474E2 w/e (PERSHING) FSN 1450-831-6942	1
Carrier, 107mm (4.2 in) Mortar, self-propelled: M84	2
Carrier, personnel, full tracked: armored, M113; M113A1	2
Carrier, utility Articulated, M571	1
Recovery Vehicles	
Recovery vehicles, full tracked: heavy M51	3
Recovery vehicle, full tracked: medium M88; light, armored M578	2

Wheeled Vehicles

Vehicle Description	Category
Amphibious Vehicles	
Transporter, amphibious self-propelled, with superstructure, end bay mobile assault bridge (MAB); interior bay mobile assault	7
Missile Vehicles	
Launcher, Rocket: 762mm truck mounted (Honest John System)	
(M139 chassis), M386, w/e	4
(M139D) chassis) M289, w/e	6

Table A2 (Cont'd)

Wheeled Vehicles -- Continued

Vehicle Description	Category
Loader-transporter, guided missile, XM501E2 w/e (HAWK) FSN 1450-768-7046	5
Loader-transporter, guided missile, XM501E3 w/e (HAWK) FSN 1450-066-8873	5
Transporters	
Transporter, CONEX, 6 x 6 16 ton	7
Trucks	
Truck, cargo: 1-1/4 ton, 6 x 6, M561	2
Truck, cargo: 2-1/2 ton, 6 x 6, M34; M35A1; M36; M36C; M135; M211	4
Truck, cargo: 5 ton 6 x 6, M41; M54	4
Truck, cargo: 5 ton, 8 x 8, M656	2
Truck, cargo: 8 ton, 4 x 4, M520	6
Truck, cargo: 10 ton, 6 x 6, M125; M125A1	6
Truck, dump: 2-1/2 ton, 6 x 6, M342A2	4
Truck, dump: 5 ton, 6 x 6, M51; M51A2	5
Truck, maintenance: 3/4 ton, 4 x 4, M201B1	4
Truck, maintenance, earthboring: 2-1/2 ton, 6 x 6, V18A/MTQ	4
Truck, maintenance, telephone construction and maintenance: 2-1/2 ton 6 x 6, V17A/MTQ	4
Truck, platform, utility: 1/2 ton, 4 x 4, M274; M2741A1; M274A2; M274A3; M274A4	2
Truck, tank, fuel servicing: 2-1/2 ton, 6 x 6, 1200 gal M217 (w/600 gal); M217C (w/600 gal)	4

Table A2 (Cont'd)

Wheeled Vehicles -- Continued

Vehicle Description	Category
Truck, tank, fuel servicing: 2500 gal, 4 x 4, M559 (GOER)	
(w/2500 gal)	7
(empty)	3
Truck, tank, water: 2-1/2 ton, 6 x 6, 1000 gal, M50	4
Truck, tank, water: 2-1/2 ton 6 x 6, 1000 gal, M222	3
Truck, tractor: 2-1/2 ton 6 x 6, M48; M221; M275 (w/o payload)	2
Truck, tractor: 5 ton, 6 x 6, M52; M52A1 (w/o payload)	2
Truck, tractor: 10 ton 6 x 6, M123; M123C; M123D (w/o payload)	3
Truck, tractor: 12 ton 6 x 6, M26A1 (w/o payload)	5
Truck, tractor, wrecker: medium, 5 ton, 6 x 6, M246 (w/payload)	5
Truck, utility: 1/4 ton 4 x 4, M38; M38A1; M38A1C; M151; M422A1	2
Truck, van, expansible: 2-1/2 ton, 6 x 6, M292	5
Truck, van, shop: 2-1/2 ton, 6 x 6, M109A1	4
Truck, wrecker, crane: 2-1/2 ton, 6 x 6, M108	4
Truck, wrecker, light: 2-1/2 ton, 6 x 6, M60	5
Truck, wrecker, medium: 5 ton, 6 x 6, M62; M543	5
Truck, wrecker: 10 ton 4 x 4, M553 (GOER)	6

Construction Equipment

Earthmoving Tractors	
Tractor, full tracked, low speed: DED, all models	2
Tractor, full tracked, 5 ton universal ballastable, (Universal Engineer Tractor)	2

Table A2 (Cont'd)

Construction Equipment -- Continued

Vehicle Description	Category
Tractor, wheeled, industrial: DED, medium dbp, w/bulldozer front,	
Clark Model 290M	5
FSN Model 2420-088-9384	
Caterpillar Model 830M	4
FSN 2420-806-0031	
Cranes and Loaders	
Crane shovel, basic unit, crawler mtd: 2 cu yd 40 ton Baldwin-Lima-Hamilton FSN 3810-230-3821	3
Crane shovel basic unit, crawler mtd: 10 ton 3/4 cu yd, "UNIT" Model 1020 yd FSN 3810-255-7593	1
Crane shovel, crawler w/catwalk: 2 cu yd, 40 ton, Bucyrus-Erie FSN 3810-263-3068	3
Crane, revolving, crawler mtd: 30-40 ton, Thew Shovel L-82	3
Crane, wheel mounted: 3/8 cu yd 5 ton, DED, 4 x 4, rough terrain, air transportable, Koehring Model M7 FSN 3810-828-4457	6
Crane, wheel mounted 20 ton, 3/4 cu yd, rough terrain, 4 x 4 FSN 3810-060-2735	6
Loader, bucket type: full tracked, DED 3 cu yd per min, Haiss Model 77-PC	2

Table A2 (Cont'd)

Truck/Trailer Combinations

Vehicle Description	Category
Truck Utility 1/4 ton M151A2 towing 1/4 ton cargo trailer M416, 2 wheels	3
Truck, cargo 1-1/4 ton M561 towing 3/4 ton cargo trailer M101A1, 2 wheels	3
Truck, cargo 1-1/4 ton M715E1 towing 3/4 ton cargo trailer M101A1, 2 wheels	5
Truck, cargo 2-1/2 ton M35A2 towing 1-1/2 cargo trailer M105A2, 2 wheels	5
Truck, tractor 5 ton M818 towing, 12 ton semi-trailer M127A1, 4 wheel	7
Truck, tractor 10 ton M123A1C towing 25 ton trailer M127A1, 4 wheel, low bed	7

APPENDIX B:

VEGETATION AND WILDLIFE RATING FORMS

Area ______________________

Rating ____________ Rank ________

VEGETATION Limitation ______________________________________

Resources	Relative Value	Categorical Value	Susceptibility to Damage	Categorical Susceptibility	Combined Resource Value	Notes
DOMINANT GROUND COVER						
DOMINANT SHRUB STRATA						
DOMINANT TREE STRATA						
RARE/ENDANGERED SPECIES						
PEST SPECIES						
ECONOMIC VALUE						
Other						
	Total Area Value		Total Combined Resource Value			

Figure B1. Vegetation rating form.

Area ______________________

Rating ____________ Rank ________

WILDLIFE ______ Limitation ______________________________

____

Resources	Relative Value	Categorical Value	Susceptibility to Damage	Categorical Susceptibility	Combined Resource Value	Notes
TERRESTRIAL SPECIES						
______						
AQUATIC SPECIES						
______						
HUNTING / FISHING						
______						
RARE / ENDANGERED SPECIES						
______						
PEST SPECIES						
______						
AESTHETICS						
______						
Other						
______						
Total Area Value			Total Combined Resource Value			

Figure B2. Wildlife rating form.

APPENDIX C:

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